QUARTERLY

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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.

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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,

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

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

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

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 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.

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

— NEW BOOKS —

Nonlinear mathematics. By Thomas L. Saaty and Joseph Bram. Dover Publications, Inc., New York, 1981. xv + 381 pp. $6.50.

This is an unabridged republication of the work originally published in 1964 by McGraw-Hill, Inc.

Multiobjective decision analysis with engineering and business applications. By Ambrose Goichoechea, Don R. Hansen and Lucien Duckstein. John Wiley & Sons, New York, 1982. xvii + 519 pp. $34.95.

This book presents in a comprehensive manner some salient aspects of multiobjective techniques, as tools that can be useful in the decision-making process. Throughout, an effort is made to identify, classify, and review these techniques as (1) solution-generating, (2) techniques that rely on prior articulation of preferences by the decision maker, (3) those that rely on progressive articulation of preferences, and (4) techniques with posterior articulation of preferences. Such classification recognizes the comparative advantage of bringing the decision maker's preferences into the different stages of an analysis in order to rank the various alternative solutions. Both continuous and discrete methods are examined. There are many case-studies, such as land reclamation after coal strip-mining activities, water-resource planning, academic planning, manpower planning, capital budgeting, facility location, etc.

From A to Z: Proceedings of a symposium in honour of A. C. Zaanen. Edited by C. B. Huijsmans, M. A. Kaashoek, W. A. Luxemburg and W. K. Vietsch. Mathematisch Centrum, Amsterdam, 1982. vii + 130 pp. $6.25.

This is Mathematical Centre Tract #149. It contains the three invited lectures delivered at the symposium: Some recent results on positive groups and semi-groups, by H. H. Schaefer; The background to Cauchy's definition of the integral, by F. Smithies; Some lattice properties of the space L^2 by B. Sz.-Nagy; and nine cntributed papers, as well as a curriculum vitae of A. c. Zaanen and lists of his publications and Ph.D. students.

Matrix polynomials. By I. Gohberg, P. Lancaster, and L. Rodman. (Computer Science and Applied Mathematics.) Academic Press, London and New York, 1982. xiv + 409 pp. $44.00.

This book provides a comprehensive treatment of the theory of matrix polynomials, which are polynomials of a complex variable with matrix coefficients. Basic matrix theory may be viewed as a theory of matrix polynomials $I\lambda - A$ of first degree. The theory developed here is a natural extension to polynomials of higher degrees, and forms an important new part of linear algebra for which the main concepts and results have been arrived at during the past five years. The material has important applications in differential equations, boundary-value problems, the Wiener-Hopf technique, system theory, analysis of vibrations, network theory, filtering of multiple time series, numerical analysis and other areas. The thirteen chapters are divided into three parts: monic, nonmonic and self-adjoint matrix polynomials, and there are six supplementary chapters in linear algebra, which make the book accessible even to undergraduate students who have studied matrix theory and complex analysis.

Modern nonlinear equations. By Thomas L. Saaty. Dover Publications, Inc., New York, 1981. vi + 471 pp. $8.50.

This is a revised, corrected republication of the work first published by McGraw-Hill, Inc., in 1967.

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Finite simple groups: An introduction to their classification. By Daniel Gorenstein. Plenum Press, New York and London, 1982. x + 333 pp. $29.50.

This is a volume in The University Series in Mathematics. "In February 1981, the classification of the finite simple groups was completed, representing one of the most remarkable achievements in the history of mathematics. Involving the combined efforts of several hundred mathematicians from around the world over a period of 30 years, the full proof covered something between 5,000 and 10,000 journal pages, spread over 300 to 500 individual papers" (from the author's introduction). Although the book is aimed at a mathematical audience, portions of it should be of interest to physicists, crystallographers, and other scientists. There are four chapters: 1. Local analysis and the four phases of the classification, 2. The known simple groups, 3. Recognition theorems, 4. General techniques of local analysis. There is a bibliography of 324 items.

Point processes and queues: Martingale dynamics. By Pierre Bremaud. Springer-Verlag, New York, Heidelberg, Berlin, 1981. xix + 354 pp. $38.00.

This is a volume in the Springer Series in Statistics. Its approach to the subject of point processes is radically different from the traditional measure-theoretic approaches: it was motivated by the need for a dynamical model which takes the information dynamics into account in a direct and effective manner, and by the necessity of controlling a system on line on the basis of the data collected at the time of the implementation of the control. The ideal tool in this respect is martingale theory, which indeed fully acknowledged the existence of information patterns that increase with time, i.e. filtrations. Martingale theory is therefore the framework in which the notion of stochastic intensity is formalized in this book. Using the martingale point of view, the notion of stochastic intensity is formalized in this book. Using the martingale point of view, the notion of stochastic intensity receives a rigorous mathematical definition, and is the basis on which a martingale calculus is constructed which has the same power as Itô calculus for diffusion: it allows a unified treatment of dynamical point process systems along the same lines as the theories previously developed for Wiener-driven stochastic systems. Perhaps one of the most mportant achievements of the martingale approach is to be found in queueing theory. Chapter headings: 1. Martingales. 2. Point Processes, Queues, and Intensities. 3. Integral Representation of Point-Process Martingales. 4. Filtering. 5. Flows in Markovian Networks of Queues. 6. Likelihood Ratios. 7. Optimal Control. 8. Marked Point Processes. There are four appendices giving background material.

Mechanics of solids with applications to thin bodies. By Gerald Wempner. Sijthoff & Nordhoff International Publishers, The Netherlands, 1981. xvii + 633 pp. $79.00.

This is volume two in the series Mechanics of Elastic and Inelastic Solids. It is its principal goal to build a bridge between the most fundamental concepts of continuous media and the practical theories of structures. Chapter headings: 1. Introduction, 2. Deformation, 3. Stress, 4. Behaviour of Materials, 5. Linear Theories of Isotropic Elasticity and Viscoelasticity, 6. Extension, Flexure, and Torsion of Rods, 7. Elastic Plates, 8. Mechanics of Curved Rods, 9. Energy Principles, 10. Curvilinear Coordinates, 11. Differential Geometry of a Surface, 12. Theory of Shells.

Micromechanics of defects in solids. By Toshio Mura. Martinus Nijhoff Publishers, The Hague, Boston, London, 1982. xii + 494 pp. $98.00.

This is volume three in the series Mechanics of Elastic and Inelastic Solids. Micromechanics encompasses mechanics related to microstructures of materials. The method employed is a continuum theory of elasticity yet its applications cover a broad area relating to the mechanical behavior of materials: plasticity, fracture and fatigue, constitutive equations, composite materials, polycrystals, etc. These subjects are treated in this book by means of a powerful and unified method called the 'eigenstrain method.' In particular, problems relating to inclusions and dislocations are most effectively analyzed by this method, and therefore special emphasis is placed on these topics. Chapter headings: 1. General theory of eigenstrains. 2. Isotopic inclusions. 3. Anisotropic inclusions. 4. Ellipsoidal inhomogeneities. 5. Cracks. 6. Dislocations. 7. Material properties and related topics.

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Foundations of modern analysis. By Avner Friedman. Dover Publications, Inc., New York, 1982. vi + 250 pp. $5.50.

This is an unabridged and corrected republication of the work originally published in 1970 by Holt, Rhinehart and Winston, Inc.

Applied time series analysis II. Edited by David F. Findley. Academic Press, London and New York, 1981. xii + 798 pp. $49.50.

This volume contains papers that are elaborations, in some cases very substantial ones, of addresses given at the Second Applied Time Series Symposium, which took place in Tulsa, March 3–5, 1980. There is an introduction to the papers by David F. Findley in which descriptions are given of the contents of the twenty-one papers in the volume. The authors come from varied backgrounds—astronomy, econonics, automatic control, information theory, signal processing, geophysics, mathematics, seismology, and of course, statistics.

Handbook of applicable mathematics, volume III: Numerical methods. Edited by Robert F. Churchhouse. John Wiley & Sons, New York, 1981. xvii + 565 pp. $85.00.

This is the third of the six core volumes of this comprehensive handbook, aimed at non-mathematicians. Table of contents: 1. Introduction to Numerical Methods. 2. Computation and Interpolation of Functions. 3. The Solution of Systems of Linear Equations. 4. Matrix Computations. 5. Non-Linear Equations. 6. Curve Fitting and Approximation of Functions. 7. Quadrature. 8. Ordinary Differential Equations. 9. Partial Differential Equations. 10. Integral Equations. 11. Numerical Optimization. There is an appendix of Fortran programs.

Numerical methods for engineering application. By Joel H. Ferziger. John Wiley & Sons, New York, 1981. xii + 270 pp. $25.95.

This book surveys the numerical methods of interpolation, integration, and ordinary and partial differential equations in a manner useful for engineering applications.

Dynamic programming: Models and applications. By Eric V. Denardo. Prentice-Hall, Inc., Englewood Cliffs, NJ, 1982. xii + 227 pp. $26.95.

This volume presents the basic material of the subject, accessible to readers who have had one prior course in operations research, including elementary probability theory. There are eight chapters: 1. Introduction to Sequential Decision Processes. 2. The Prototype Sequential Decision Process. 3. Allocation, Marginal Analysis, and Lagrange Multipliers. 4. Stages, Grids, and Discretizing Control Problems. 5. Production Control and Network Flow. 6. A Markov Decision Model. 7. Inventory Control: (s, S)-Policies. 8. A Discounted Markov Decision Model.

Comparative statistical inference. By Vic Barnett. John Wiley & Sons, New York, 1982. xv + 325 pp. $38.00.

This is the second edition of a volume in the Wiley Series in Probability and Mathematical Statistics, first published in 1973. It is a comprehensive comparative treatment of statistical inference and decision-making, addressed both to advanced students in statistics and to workers in other disciplines. The new edition provides more detailed treatment of some topics, offers some discussion of new emphases, techniques and whole approaches to inference, and reflects changes of basic attitude to the subject. For instance, greater attention is givebn to practical ways of representing and assessing subjective probabilities and utilities, and to work on the application of Bayesian methods.

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The solution of the inverse problem in geophysical interpretation. Edited by R. Cassinis. Plenum Press, New York, 1981. ix + 381 pp. $45.00.

This is volume 11 of the Ettore Majorana International Science Series. It contains the lectures delivered at the Third Course of the International School of Applied Geophysics, held at Erice, Sicily, March 27–April 4, 1980. There is an introduction by R. Cassinis and, under the heading Passive and Active Seismology, eight lectures and two summaries, under the heading Geoelectric Methods, three lectures. There are seven Short Notes.

The finite element method in thin shell theory: Application to arch dam simulations. By M. Bernadou and J. M. Boisserie. Birkhauser, Boston, Inc., Cambridge, MA, 1982. x + 199 pp.

This is volume 1 in the series Progress in Scientific Computing. It has two objectives: to analyze a finite element method useful for solving a large class of thin shell problems, and to show in practice how to use this method to simulate an arch dam problem. The first objective is developed in Part I. The authors record the definition of a general thin shell model corresponding to the W. T. Koiter linear equations and show the existence and the uniqueness for a solution. By using a conforming finite element method, they associate a family of discrete problems to the continuous problem, prove the convergence method, and obtain error estimates between exact and approximate solutions. They then describe the implementation of some specific conforming methods. The second objective is developed lin Part II. It consists of applying these finite element methods to the case of a representative practical situation, i.e. an arch dam problem.

Ill-posed problems for integrodifferential equations in mechanics and electromagnetic theory. By Frederick Bloom. Society for Industrial and Applied Mathematics, Philadelphia, PA, 1981. ix + 222 pp. $34.50.

This is a volume in the SIAM Studies in Applied Mathematics. The authors consider the problem of establishing results on uniqueness, stability, and continuous data dependence for solutions to ill-posed initial-history boundary-value problems associated with systems of partial-integrodifferential equations and for solutions of the related ill-posed initial-history value problems associated with integrodifferential equations in Hilbert space. There are four chapters: 1. Ill-posed Initial Boundary Value Problems in Mathematical Physics: Examples of the Basic Logarithmic Convexity and Concavity Arguments for PDE. 2. Ill-posed Problems for the Partial Integrodifferential Equations of Linear and Nonlinear Viscoelasticity. 2. Ill-posed Problems for Some Partial-Integrodifferential Equations of Electromagnetic Theory. 4. Some Recent Directions in Research on Nonlinear Integrodifferential Equations.

Qualitative analysis of physical problems. By M. Gitterman and V. Halpern. Academic Press, New York, 1981. xiv + 274 pp.

The aim of this book is to present a general review of the essential features of all the main approaches used for the qualitative analysis of physical problems, and to demonstrate their application to problems from a wide variety of fields. It is intended not only for those who wish to learn and apply these methods, but also for those who are interested in obtaining a general perspective of modern physics. The level of background knowledge in physics expected of the reader for most of this book is that provided by university courses in general physics. The knowledge of mathematics that is assumed includes familiarity with the standard techniques for solving ordinary and partial differential equations. Five general principles are relevant to the mathematical formulation and solution of almost all scientific problems, namely (i) the construction of a model, (ii) dimensional analysis, (iii) the symmetry of the problem, (iv) the analytic properties of the physical quantities involved, and (v) the method of the small parameter. These principles are treated in detail in the body of the book.

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Spacetime and geometry: The Alfred Schild lectures. Edited by Richard A. Matzner and L. C. Shepley. University of Texas Press, Austin, TX, 1982. x + 189 pp. $37.50.

These articles represent current research topics at a level suitable for graduate students in physics. Each is based on a lecture from the Alfred Schild Memorial Lecture Series at the University of Texas at Austin; they are: Why is the universe so symmetrical, by Dennis Schiama; Null Consequences and Plebanski-Schild spaces, by Ivor Robinson; Linearization stability, by Dieter Brill; Nonlinear model field theories based on harmonic mappings, by Charles W. Misner; Gravitational fields in general relativity, by Roy P. Kerr; On the potential barriers surrounding the Schwarzschild black hold, by Subrahmanyan Chandrasekhar; The initial value problem and beyond, by James W. York, Jr., and Tsvi Piran.

E. B. Christoffel: The influence of his work on mathematics and the physical sciences. Edited by P. L. Butzer and F. Feher. Birkhauser Verlag, Boston, MA, 1981. xxv + 761 pp.

This volume contains 55 invited papers by specialists from 15 countries. A number of these contributions deal with Christoffel's work and its subsequent influence, providing basic surveys of important fields in the mathematical and physical sciences over the past 100 years. Some forty papers are concerned with specialized topics in fields in which Christoffel worked, with the emphasis on recent developments. The topics treated include Gauss-Christoffel quadrature formulae; orthogonal polynomials, Padé approximation and continued fractions; the Christoffel-Schwarz transformation, and conformal representation; theta functions, automorphic functions and Riemann surfaces; differential equations and potential theory; shock waves and continuum mechanics; Riemannian geometry and submanifolds; invariant theory, differential operators and field physics; affine and projective structures, nonlinear differential geometry; G-spaces, convex bodies and foundations as well as dynamical systems, mechanical ether theories and the dispersion of light. Finally there are several historical articles on Christoffel and his time.

Handbook of applicable mathematics—Guidebook 1: *Mathematical methods in social science.* By David J. Bartholomew. John Wiley & Sons, New York, 1981. ix + 153 pp. $26.50 cloth, $14.50 paperback.

This is a volume in the series Handbook of Applicable Mathematics. The Handbook will consist of six "core" volumes (algebra, probability, numerical methods, analysis, geometry and combinatorics, statistics) and several "guidebooks", each devoted to an application. Each guidebook will have references to the appropriate core volumes. This is one of the guidebooks. It reviews the mathematical and statistical methods used by sociologists and social scientists, concentrating on the problems they will encounter rather than on mathematical techniques. Table of Contents: 1. Introduction, 2. Pattern, Variation and Inference. 3. Collection of Data: Design and Analysis of Surveys. 4. Multivariate Methods in Social Science. 5. The Dynamics of Social Systems.

Mathematical programming and games. By Edward L. Kaplan. John Wiley & Sons, New York, 1982. xx + 588 pp. $34.95.

This is a text intended for undergraduates or first-year graduate students. The principal topics are: Simplex methods of linear programming, Related topics in linear algebra, Games in normal characteristic-function and extensive forms, Shortest trees and paths, Dynamic programming and decision making, Transportation problems. Special features include the following: an all-integer pivot procedure eliminates fractions and decimals in small exercises; duality theory is made easy and used from the outset with variables x, y, z in the row of equations u_i, v_j, w in the column equations; answers are provided for the exercises—an average of about 10 for each of 74 sections; a selected bibliography includes 375 references—from 1851 to 1981; the current state of research is reported for multiple objectives functions, and for the Shapley and Banzhaf values for games.