

QUARTERLY
OF
APPLIED MATHEMATICS

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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.

Manuscripts (two copies) submitted for publication in the QUARTERLY OF APPLIED MATHEMATICS should be sent to the Editorial Office, Box F, Brown University, Providence, R.I. 02912, either directly or through any one of the Editors or Collaborators. 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 proofs only. The authors' institution will be requested to pay a publication charge of \$30.00 per page which, if honored, entitles them to 100 free reprints. Instructions will be sent with galley proofs.

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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: Papers should be submitted in original typewriting on one side only of white paper sheets and be double or triple spaced with wide margins. Marginal instructions to the printer should be written in pencil to distinguish them clearly from the body of the text.

The papers should be submitted in final form. Only typographical errors may be corrected in proofs; composition charges for all 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 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 to follow his name.

Mathematical Work: As far as possible, formulas should be typewritten; Greek letters and other symbols not available on the typewriter should be carefully inserted in ink. Manuscripts containing pencilled material other than marginal instructions to the printer 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 in exponents should be clearly indicated. Dots, bars, and other markings to be set *above* letters should be strictly avoided because they require costly hand-composition; in their stead markings (such as primes or indices) which *follow* the letter should be used.

Square roots should be written with the exponent $\frac{1}{2}$ rather than with the sign $\sqrt{\quad}$. 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,

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

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 printed formulas. To avoid misunderstanding, the order of symbols should therefore be carefully considered. Thus,

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

In handwritten formulas the size of parentheses, brackets and braces can vary more widely than in print. Particular attention should therefore be paid to the proper use of parentheses, brackets and braces. Thus,

$$\{[a + (b + cx)^n] \cos ky\}^2 \text{ is preferable to } ((a + (b + cx)^n) \cos ky)^2.$$

Cuts: Drawings should be made with black India ink on white paper or tracing cloth. It is recommended to submit drawings of at least double the desired size of the cut. The width of the lines of such drawings and the size of the lettering must allow for the necessary reduction. Drawings which are unsuitable for reproduction will be returned to the author for redrawing. Legends accompanying the drawings should be written on a separate sheet.

Bibliography: References should be grouped together in a Bibliography at the end of the manuscript. References 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 it.

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 Strömung zäher 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 like 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 like 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.

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Optimal control of discrete systems. By V. G. Boltyanskii. Translated by Ron Hardin. John Wiley and Sons, New York, 1978. x + 392 pp. \$57.50.

There are five chapters in this book. Chapter I contains a preliminary discussion of the optimal control of discrete objects, which may be considered a self-contained introduction to the subject, sufficient to acquaint a reader with its fundamentals. Chapter II presents the basic facts associated with the theory of finite-dimensional vector spaces, affine geometry and Euclidean geometry, the latter on the basis of the axiomatics of Weyl. Chapter III contains the necessary information from the theory of convex sets, with complete proofs. Chapter IV deals mainly with problems in mathematical programming such as the Kuhn-Tucker theorem. Chapter V, which discusses optimality criteria for optimal control, is the main chapter of the book as far as the title subject is concerned. Here the necessary and sufficient conditions for optimality are presented in as general a form as possible. A new version of the discrete maximum principle is also given, obtained by using the "method of local sections", a technique applied earlier by the author to the theory of continuous optimal control. The book thus consists of five essentially self-contained small books all contributing to the main theme.

Numerical solution of highly nonlinear problems: fixed-point algorithms and complementarity problems. Edited by Walter Forster. North-Holland Publishing Co., Amsterdam and New York, 1980. xiv + 444 pp. \$53.75.

This book is based on papers presented at the Symposium on Fixed-Point Algorithms and Complementary Problems held in July 1979 at the University of Southampton. Fixed-point algorithms can be regarded as the culmination of 70 years of mathematical research, and the papers in this volume represent the present state of development in this field. The papers presented are either extensions of those presented at the symposium or have been specially prepared for this publication. These papers cover new theoretical developments, new algorithms, various applications such as economic models, etc., computer implementations, and historical background.

Finite dynamic programming: an approach to finite Markov decision processes. By D. J. White. John Wiley & Sons, New York, 1978. xiii + 204 pp. \$29.95.

This text deals with the dynamic-programming approach to standardized finite-state, finite-action, bounded-reward Markov decision processes, over finite and infinite time horizons. The emphasis is on the study of the functional equations governing these processes, and of algorithms for solving them. Chapter headings: 1. The optimal route problem; 2. Optimal discounting over time with single-period decision epochs; 3. Optimal non-discounting over time with single-period decision epochs; 4. Optimal discounting over time with multi-period decision epochs; 5. Optimal nondiscounting over time with multi-period decision epochs; 6. Optimizing over n transitions; 7. Linear programming formulations; 8. Probabilistic constraints; 9. Aspects of optimality.

Solution methods for integral equations: theory and applications. Edited by Michael A. Golberg. Plenum Press, New York, 1979. ix + 350 pp. \$35.00.

The essays included in this volume discuss many of the better-known solution methods with particular emphasis on the initial-value methods introduced by Chandrasekhar, Sobolev, Bellman, Kalaba and Kagiwada and on the numerical solution of Cauchy singular integral equations. There are now existence-uniqueness theories for several classes of integral equations, although the volume focuses primarily on practical methodology. Also included is a comprehensive survey on the state of the art; there are up-to-date bibliographies in each chapter. The contributors are: R. C. Allen, J. M. Bownds, J. Casti, D. Elliott, J. A. Fromme, M. A. Golberg, A. Goldman, H. Kagiwada, R. Kalaba, L. B. Rall, W. Visscher, G. Wahba, G. M. Wing.

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Dynamic optimization and economic applications. By Ronald E. Miller. McGraw-Hill Book Co., New York, 1979. x + 332 pp. \$29.50.

The object of this book is to provide an introduction to the techniques of optimal control theory and their applications in the social sciences. The necessary mathematical fundamentals are included in appendices. Chapter headings: 1. Introduction; 2. The calculus of variations: fundamentals, 3. The calculus of variations: more advanced results, 4. The maximum principle; 5. Models in economics and regional science; four appendices.

Digital foundations of time series analysis. Volume 1: the Box-Jenkins approach. By E. A. Robinson and M. T. Silvia. Holden-Day, Inc., San Francisco, 1979. viii + 451 pp. \$35.00.

This book gives a self-contained development and explanation of the Box-Jenkins method of time series analysis, assuming only the equivalent of a year's course in statistics. The classical simple and multiple regression models and the linear systems models are first developed to provide a framework for the Box-Jenkins approach. The book can serve as a text for a one-semester course and also as a reference for those engaged in empirical time series analysis.

Circuit analysis with computer application to problem solving. By S. C. Gupta, J. W. Bayless and B. Peikari. Matrix Publishers, Champaign, Illinois, 1977. xiii + 546 pp. \$25.95.

This book is the outgrowth of class notes written for a two-semester sophomore/junior level course at the Southern Methodist University. This course was designed to integrate basic circuit analysis with the use of the digital computer as a tool.

Lie algebras. By Nathan Jacobson. Dover Publications Inc., New York, 1979. ix + 331 pp. \$5.00.

This is a reprint of the 1962 edition published by John Wiley and Sons (Interscience).

Inequalities: theory of majorization and its applications. By A. W. Marshall and I. Olkin. Academic Press, Inc., New York, 1979. xx + 559 pp. \$49.50.

The subject of this book had its origin in the famous book *Inequalities* by Hardy, Littlewood and Polya. Although they play a fundamental role in nearly all branches of mathematics, inequalities are usually obtained by ad hoc methods rather than as consequences of some underlying "theory of inequalities." For certain kinds of inequalities, the notion of majorization leads to such a theory that is sometimes extremely useful and powerful for deriving inequalities. Moreover, the derivation of an inequality by methods of majorization is often very helpful both for providing a deeper understanding and for suggesting natural generalizations. The idea of majorization is a special case of several more general notions, but these generalizations are mentioned in this book only for the perspective they provide. The authors have limited themselves to various aspects of majorization partly because they want to emphasize its importance and partly because of its simplicity. However, to make the book reasonably self-contained, five chapters at the end of the book are included which contain complementary material. The book is organized so that it can be used in a variety of ways for a variety of purposes. Sequential reading is not necessary. Extensive cross-referencing has been attempted so that related material can easily be found. The twenty chapters are grouped in five parts: 1. Theory of majorization; 2. Mathematical applications; 3. Stochastic applications; 4. Generalizations; 5. Complementary topics.

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Principles of statistics. By M. G. Bulmer. Dover Publications, Inc., New York, 1980. 252 pp. \$3.50.

The first edition was published by Constable, London, in 1967. It is an elementary introduction to the subject.

Vibrations of elastic structural members. By Edward B. Magrab. Sijthoff & Noordhoff, The Netherlands, 1979. xiv + 390 pp. \$60.00.

This book presents a comprehensive development and applications of the normal-mode method to determine the response of elastic structural members under a wide variety of boundary conditions and applied forces. Chapter I contains a summary of virtually all the mathematical tools required in the subsequent chapters. The remaining nine chapters cover the vibrations of strings, membranes, beams, plates and shells.

Introduction to dynamic systems: theory, models, and applications. By David G. Luenberger. John Wiley and Sons, New York, 1979. xiv + 446 pp. \$19.95.

This book is an outgrowth of a course developed at Stanford University over the past five years. It is suitable as a self-contained textbook for second-level undergraduates or for first-level graduate students in almost every field that employs quantitative methods. As prerequisites, it is assumed that the student may have had a first course in differential equations and a first course in linear algebra or matrix analysis. These two subjects, however, are reviewed insofar as they are required for later developments. The objective of the book is to help the students develop the ability to analyze real dynamic phenomena and dynamic systems. This objective is pursued through the presentation of theory, models and applications of dynamical systems.

Vector and tensor analysis with applications. By A. I. Borisenko and I. E. Tarapov. Translated by Richard A. Silverman. Dover Publications, Inc., New York, 1979. x + 257 pp. \$4.50.

This is an unabridged and corrected republication of the work originally published by Prentice-Hall. It is a freely revised and restyled version of the third edition of the original (Moscow, 1966).

Algebraic number theory. By I. Stewart and D. Tall. Chapman and Hall, London, 1979. xviii + 257 pp.

The aim of this book is to illustrate how some of the basic notions of the theory of algebraic numbers may be applied to problems in number theory. The book is divided into three parts. The first develops the basic theory from an algebraic standpoint, the second emphasizes the power of geometric methods arising from Minkowski's theorem on convex sets relative to a lattice, and the third concentrates on applications of the theory thus far developed.

Geometric quantization and quantum mechanics. By Jędrzej Sniatycki. Springer-Verlag, New York, 1980. ix + 230 pp. \$14.00.

This is volume 30 of the series Applied Mathematical Sciences. It contains a revised and expanded version of the lecture notes of two seminar series given during the academic year 1976/77 at the Department of Mathematics and Statistics of the University of Calgary, and in the summer of 1978 at the Institute of Theoretical Physics of the Technical University Clausthal. The aim of the seminars was to present geometric quantization from the point of view of its applications to quantum mechanics, and to introduce the quantum dynamics of various physical systems as the result of the geometric quantization of the classical dynamics of these systems.

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Hill's equation. By Wilhelm Magnus and Stanley Winkler. Dover Publications, Inc., New York, 1979. viii + 129 pp. \$3.00.

This is an unabridged and corrected republication of the work originally published by John Wiley & Sons in 1966. There is a new preface and a list of additional references, prepared by the authors.

Applications of linear algebra. 2nd edition. By Chris Rorres and Howard Anton. John Wiley & Sons, New York, 1979. ix + 295 pp. \$6.95.

This is the second edition of a 1977 text discussing linear algebra applications in business, economics, engineering, physics, computer science, geometry, approximation theory, ecology, sociology, demography and genetics.

Mechanics. By W. Chester. George Allen & Unwin, London, Boston, Sydney, 1979. xv + 432pp.

This is an introduction to the mechanics of particles and rigid bodies, assuming some familiarity with calculus but none with differential equations. Three-dimensional rigid body mechanics is included, but without tensor calculus.

C-algebras and their automorphism groups.* By Gert K. Pedersen. Academic Press, Inc., London, New York, San Francisco, 1979. ix + 415 pp.

The theory of C*-algebras is the study of operators on Hilbert space with algebraic methods. The motivating example is the spectral theorem for a normal operator (which, in effect, is a Gelfand transformation applied to the algebra generated by the operator). The applications of the theory range from group representations to model quantum field theory and quantum statistical mechanics. Chapter headings: 1. Abstract C*-algebras; 2. Concrete C*-algebras; 3. Functionals and representations; 4. Decomposition theory; 5. Weights and traces; 6. Type IC*-algebras; 7. Automorphism groups; 8. Spectral theory for automorphism groups.

Convexity in the theory of lattice gases. By R. B. Israel. With an introduction by Arthur S. Wightman. Princeton University Press, New Jersey, 1979. lxxxv + 167 pp. \$16.50 (cloth); \$6.95 (paper).

This is a volume in the Princeton Series in Physics. In it, the author considers classical and quantum lattice systems in terms of equilibrium statistical mechanics. He is especially concerned with the characterization of translation-invariant equilibrium states by a variational principle and the use of convexity in studying these states. Wightman's introduction gives a general and historical perspective on convexity in statistical mechanics and thermodynamics. Chapter headings: 1. Interactions; 2. Tangent functionals and the variational principle; 3. DLR equations and KMS conditions; 4. Decomposition of states; 5. Approximation by tangent functionals: Existence of phase transitions; 6. The Gibbs phase rule.

Constructive approaches to mathematical models. Edited by C. V. Coffman and G. J. Fix. Academic Press, Inc., New York, 1979. xviii + 459 pp. \$45.00.

These are the proceedings of a conference in honor of R. J. Duffin held at Pittsburgh in July 1978. The papers, devoted to areas to which Duffin has made substantial contributions, are divided into six groups: 1. General talks (Some problems arising from mathematical models, by R. J. Duffin; Some recollections from 30 years ago, by Raoul Bott; Transforms, by D. G. Bourgin. 2. Graphs and networks (four papers). 3. Mathematical programming (eight papers). 4. Differential equations (four papers). 5. Mathematical models (three papers). 6. Related areas (eight papers).

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Econometrics. 2nd edition. By R. J. Wonnacott and T. H. Wonnacott. John Wiley & Sons, New York, 1979. xxiii + 580 pp. \$21.95.

This is the second edition of a volume in the Wiley Series in Probability and Mathematical Statistics, first published in 1970. It is written in two parts, elementary and more advanced, and is thus designed for two courses on different levels—the second part for graduate students with the necessary background in mathematics and statistics. The new edition includes a number of new topics, such as an entirely new chapter on logit models and estimation of elasticity, more time series material, principal components, and other material.

Operator colligations in Hilbert spaces. By M. S. Livshits and A. A. Yantsevich. Translated by the American Mathematical Society. John Wiley & Sons, New York, 1979. xiii + 212 pp. \$19.95.

If energy is given by a quadratic form, one has a space which, when completed, yields a Hilbert space. If energy is conserved then the operator in question is unitary and hence the exponential of a self-adjoint operator. However, energy is not conserved in all systems, which are generally dissipative leading to the study of dissipative operators. Such study was commenced in the late 1940s by Mikhail S. Livshits who introduced the notion of characteristic operator functions. In this book Profs. Livshits and Yantsevich enlarge upon this concept by further developing the notion of an operator colligation which arose out of their earlier work. In the second part, they tackle the subject of nonstationary stochastic processes, showing how the earlier work on dissipative operators can be used to study the prediction problem for such processes.

Finite Markov processes and their applications. By Marius Iosifescu. John Wiley & Sons, New York, 1980. 295 pp. \$32.50.

This is a volume in the Wiley Series in Probability and Mathematical Statistics. It is a complete and thorough treatment of finite Markov chains. Chapter headings: 1. Elements of probability theory and linear algebra; 2. Fundamental concepts in homogeneous Markov chains theory; 3. Absorbing Markov chains; 4. Ergodic Markov chains; 5. General properties of Markov chains; 6. Applications of Markov chains in psychology and genetics; 7. Nonhomogeneous Markov chains; 8. Markov processes.

Applied statistical techniques. By K. D. C. Stoodley, T. Lewis, and C. L. S. Stainton. John Wiley & Sons, New York, 1980. 310 pp. \$56.95.

This book treats regression analysis, design and analysis of experiments, nonparametric methods, sampling inspection and quality control, sample surveys, and forecasting with a review of the statistical background required.

Applied stochastic processes. Edited by G. Adomian. Academic Press, New York, 1980. ix + 301 pp. \$21.00.

These are the proceedings of a conference held in May, 1978 at the Center for Applied Mathematics, University of Georgia. There are twelve papers, by G. Adomian, G. A. Bécus, B. V. Bronk, P. L. Chow, G. S. Ladde and V. Lakshmikantham, M. D. Lax, W. J. Padgett, Michael F. Shlesinger and Uzi Landman, Leon H. Sibul, C. P. Tsokos and A. Rust III, and B. J. West.

Computing methods in applied sciences and engineering. Edited by R. Glowinski and J. L. Lions. North-Holland, Amsterdam, and New York, 1980. ix + 724 pp. \$68.25.

This book is the proceedings of the Fourth International Symposium on computing methods in applied sciences and engineering held in Versailles, December 10–14, 1979. The papers in these proceedings are divided into ten groups: 1. Numerical methods in nonlinear mechanics; 2. Numerical methods in bifurcation and applications; 3. Fluid mechanics; 4. Plasma physics; 5. Free boundary problems; 6. Numerical linear algebra and related topics; 7. Non-linear programming and applications; 8. Inverse problems in seismology; 9. Biomathematics; 10. Asymptotic perturbation methods.

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Dynamics and modelling of reactive systems. Edited by Warren E. Stewart, W. Harmon Ray and Charles C. Conley. Academic Press, New York, 1980. xi + 413 pp. \$27.50.

This volume represents the proceedings of a seminar held at the University of Wisconsin on October 22–24, 1979. The goals of the seminar were (i) to assess the current level of understanding of the dynamics of chemically reacting systems, and (ii) to provide a forum for exchange of ideas between engineers and mathematicians working in this area.

Search games. By Shmuel Gal. Academic Press, New York, 1980. xiv + 216 pp.

This monograph deals with the problem of finding optimal search trajectories in order to locate a target. The general approach used is to look upon the situation as a game between a searcher and a hider and to present optimal strategies for both participants in this game. In some of the problems, the hider is assumed to be stationary, while in others the hider is allowed to move and evade the searcher as long as possible. In most cases, it is assumed that there is one hider and one searcher, but sometimes it is shown how the results can be generalized to include the case of several searchers and one hider. The monograph is written mainly for those interested in search and minimax problems. A basic knowledge of game theory and probability is assumed.

Solitons. Edited by R. K. Bullough and P. J. Caudrey. Springer-Verlag, Berlin, Heidelberg, New York, 1980. xviii + 389 pp. \$44.90.

Chapter headings: 1. The soliton and its history. 2. Aspects of soliton physics. 3. The double sine-Gordon equations: a physically applicable system of equations. 4. On a nonlinear lattice (the Toda lattice). 5. Direct methods in soliton theory. 6. The inverse scattering transform. 7. The inverse scattering method. 8. Generalized matrix form of the inverse scattering method. 9. Nonlinear evolution equations solvable by the inverse spectral transform associated with the matrix Schrödinger equation. 10. A method of solving the periodic problem for the KdV equation and its generalizations. 11. A Hamiltonian interpretation of the inverse scattering method. 12. Quantum solitons in statistical physics.

Lebesgue integration. (Pure and Applied Mathematics: A series of monographs and textbooks, Volume 58.) By Soo Bong Chae. Marcel Dekker, Inc., New York, 1980. 328 pp. \$35.00.

This book presents the fundamental concepts of Lebesgue integration for readers with a background in introductory calculus. It contains a review of Riemann integration and its deficiencies, to underline the need for Lebesgue integration, an in-depth study of the fundamental theorem of calculus for the Lebesgue integral, and a discussion of L^p spaces as an application of Lebesgue theory.

New approaches to nonlinear problems in dynamics. Edited by Philip J. Holmes. SIAM, Philadelphia, 1980. xii + 529 pp. \$42.50.

These are the proceedings of a conference sponsored and organized by the Engineering Foundation and held in December 1979 at the Asilomar Conference Grounds, Pacific Grove, California. There are nine sections: 1. Mathematical methods. 2. Aerospace and mechanical engineering. 3. Chemical engineering. 4. Electrical and civil engineering. 5. Review: mathematical methods and mechanics. 6. Bifurcation with symmetry. 7. Stochastic problems. 8. Strange attractors. 9. Large-scale and distributed systems.

Fuzzy sets and systems: theory and applications. By Didier Dubois and Henri Prade. Academic Press, New York, 1980. xvii + 393 pp. \$49.50.

This book is intended to be a rather exhaustive research monograph on fuzzy set theory and its applications. The work is based on a large compilation of the literature in English, French, and German. Approximately 550 publications or communications are referred to. The monograph is divided into five parts: 1. Introduction; 2. Mathematical tools (5 chapters); 3. Fuzzy models and formal structures (4 chapters); 4. Systems-oriented fuzzy topics (10 chapters); 5. A survey of potential applications (11 sections).

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Direct integral theory. (Lecture Notes in Pure and Applied Mathematics, Volume 61.) By Ole A. Nielsen. Marcel Dekker, New York, 1980. 184 pp. \$23.50.

This is the first book completely devoted to the theory of direct integrals. The two principal areas to which this theory applies—von Neumann algebras acting on separate Hilbert spaces, and representations of both involutive Banach algebras and locally compact groups—are thoroughly covered. Three appendices at the end of this book supply all background information needed.

Parameter estimation : principles and problems. (Control and Systems Theory Series, Volume 9.) By Harold W. Sorenson. Marcel Dekker, New York, 1980. 400 pp. \$45.00.

This book is concerned with the problem of estimating the value of an unknown parameter from noisy measurements of related quantities. It is its purpose to present the fundamental concepts and major results of parameter estimation theory in a manner that will make the material accessible to as large an audience as possible. The book should be useful to both students and to practicing engineers.

Topics in graph theory. Edited by Frank Harary. Annals of the New York Academy of Sciences, vol. 328, 1979. 208 pp. \$40.00.

These are the proceedings of a meeting held at the Academy in May 1977. There are two lectures by F. Harary and twenty contributed papers.

Information linkage between applied mathematics and industry II. Edited by A. L. Schoenstadt, F. D. Faulkner, Richard Franke, and I. Bert Russak. Academic Press, New York, 1980. xii + 293 pp. \$20.00.

These are the proceedings of a symposium held at the Naval Postgraduate School in February 1979. There are four invited lectures, on interval estimation for linear models with ill-conditioned equations; robust stability of linear systems; elliptic equations in meteorology; and software for elliptic partial differential equations. The contributed papers (or abstracts) are grouped under the headings of (i) theory and computation of linear systems; (ii) least squares, regression, and systems identification; (iii) applications in controls; and (iv) general applications.

Elements of soliton theory. By G. L. Lamb, Jr. John Wiley & Sons, New York, 1980. xii + 289 pp. \$29.95.

This is a volume in the Wiley Series "Pure and Applied Mathematics". It is a self-contained introduction to the theory of solitons, concentrating on the background material and concepts that have set the stage for much of the research in the field. Chapter 1 shows the connection between a nonlinear partial differential equation that exhibits soliton behavior and a linear eigenvalue problem. Chapters 2 and 3 provide an elementary account of one-dimensional scattering methods. The Korteweg-de Vries equation is treated by inverse scattering techniques in chapter 4 and chapter 5 provides a corresponding introduction to the other most common soliton equations. Chapters 6 and 7 show how soliton equations arise in various physical contexts. Bäcklund transformations are introduced in chapter 8. Chapter 9 considers soliton perturbation theory. References to additional material are included.

Quantitative techniques in geography : an introduction. 2nd edition. By A. Hammond and P. S. McCullagh. Oxford University Press, Oxford, 1978. xx + 364 pp. \$19.95.

This is the second edition of a textbook first published in 1979. It has been enlarged and revised.

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Life testing and reliability estimation. By S. K. Sinha and B. K. Kale. John Wiley and Sons, New York, 1980. vii + 196 pp. \$16.95.

After an introductory chapter on a variety of models used to describe the failure time distributions, the authors consider in Chapter 1 the exponential model in some depth. In life testing experiments the exponential model has played a role very similar to that played by the normal distribution in agricultural experiments. Chapters 2 and 3 consider the models based on gamma, normal and other related distributions. Chapter 4 covers the mixture and compound distributions. In all these chapters the authors consider estimation problems only, as these arise in complete samples as well as the failure and time-censored samples. The methods of estimation considered are (i) maximum likelihood, (ii) uniformly minimum variance unbiased, (iii) methods of moments, and (iv) the linear combination of order statistics of the sample. Chapter 5 deals with tests of hypotheses and confidence intervals for the parameters occurring in the models, as well as the reliability function. The approach here is purely decision-theoretic, based on the Neyman-Pearson theory. Chapter 6 deals with the Bayesian approach and Chapter 7 deals with estimation of the reliability function for series as well as parallel systems. A number of illustrative examples are worked out at the end of each section and exercises are given at the end of each chapter.

Lectures Notes in Control and Information Sciences, edited by A. V. Balakrishnan and M. Thoma. Springer-Verlag, Berlin, Heidelberg, New York, 1979.

No. 8. *Infinite-dimensional linear systems theory.* By Ruth F. Curtain and Anthony J. Pritchard. vii + 297 pp., 1978. \$14.80.

This monograph reflects the research effort carried out over the past five years at the Control Theory Centre of the University of Warwick, England. The philosophy underlying the research has been to develop a mathematical framework which makes possible the generalization of finite-dimensional results to infinite dimensions and which includes both distributed-parameter systems and differential delay systems as special cases. The system dynamics is described in terms of a strongly continuous semigroup on an appropriate Banach space. Using this unifying mathematical approach the authors clarify the essential concepts of observability, controllability, the quadratic cost control problem, and the estimation and control problems for stochastic systems.

No. 12. *A complex variable approach to the analysis of linear multivariable feedback systems.* By Ian Postlethwaite and Alistair G. J. MacFarlane. 177 pp. \$9.80.

The aim of the work presented here is to extend the concepts underlying the techniques of Nyquist, Bode and Evans to multivariable systems. In the two classical approaches to linear feedback system design the Nyquist-Bode approach studies gain as a function of frequency and the Evans' approach studies frequency as a function of gain.

No. 13. *Polynomial response maps.* By Eduardo D. Sontag. viii + 168 pp. \$9.80.

This work is based on a doctoral dissertation written under R. E. Malman. It has as its premise that the natural tools for the study of the structural-algebraic properties of polynomial input/output maps (in which present output values are sums and products of past input values) are provided by algebraic geometry and commutative algebra. Only discrete-time systems are considered.

No. 14. *International symposium on systems optimization and analysis.* Edited by A. Bensoussan and J. L. Lions. viii + 332 pp. \$16.00.

The symposium was held in Rocquencourt, France, in December 1978. There were five sessions, dedicated to the following topics: economic models; identification, estimation, filtering; adaptive control; numerical methods in optimization; distributed systems.

No. 15. *Semi-infinite programming: proceedings of a workshop*. Edited by R. Hettich. viii + 178 pp. \$9.80.

These are the proceedings of a workshop held in Bad Honnef in 1978. The emphasis was on practical aspects, i.e. numerical methods and applications.

No. 16. *Stochastic control theory and stochastic differential systems*. Edited by M. Kohlmann and W. Vogel. xii + 615 pp. \$33.00.

These are the proceedings of a workshop held at Bad Honnef in January, 1979. There are 12 survey lectures, and research reports.

No. 17. *Qualitative aspects of large scale systems: developing design rules using APL*. By O. I. Frankzen, P. Falster and F. J. Evans. xii + 119 pp. \$9.00.

The monograph is constructed around the central concepts of controllability and observability. The authors feel that the work represents an investigation in the true inductive spirit from the particular to the general and that the use of an interactive APL facility allowed the work to proceed in the classical empirical manner, which demonstrates the role of a "computer laboratory" in modern systems analysis. Table of contents: 1. Background and scope; Part I: The tensorial approach; 2. The Cartesian tensor formulation; 3. The Boolean tensor formulation; Part II: The graph theoretic approach; 4. The reachability criterion; 5. The term rank criterion; Part III: Digraph decomposition and tensor aggregation; 6. On partitioning of a digraph; 7. Towards a total systems description; 8. Some general remarks. There is also an APL glossary.

No. 18. *Modelling and optimization of complex system*. Edited by G. I. Marchuk. vi + 293 pp. \$14.30.

These are the proceedings of a working conference held in Novosibirsk, USSR, in July 1978. The conference was organized by the IFID Technical Committee on Optimization, sponsored by the USSR Academy of Sciences, and emphasized mathematical models in immunology and the organization of complex systems.

No. 19. *Global and large-scale system models*. Edited by B. Larzarevic. viii + 232 pp. \$12.50.

These are the proceedings of the center for advanced studies held at Dubrovnik, Yugoslavia, in August 1978. The objective of the seminar was to discuss fundamental problems and different approaches to large-scale system modeling, with applications to corporate models, national economy models and world models.

No. 20. *Stability of adaptive controllers*. By Bo Egardt. v + 158 pp. \$9.80.

This monograph has its origin in a doctoral thesis, presented at the Department of Automatic Control, Lund Institute of Technology and supervised by Karl Johan Åström, one of the pioneers of control theory and practice. The attention is focused on two well-known approaches; the model reference adaptive systems and the self-tuning regulators.

Applied inverse problems. Lectures presented at the RCP 264 "Etude Interdisciplinaire des Problèmes Inverses" sponsored by the Centre National de la Recherche Scientifique. Edited by P. C. Sabatier. Springer-Verlag, Berlin, Heidelberg, New York, 1978. v + 425 pp. \$19.50.

This is volume 85 of Lecture Notes in Physics. There is an introduction by P. C. Sabatier and are fifteen review lectures on special applications and one theoretical lecture on solutions of inverse problems.

International Series of Numerical Mathematics. Birkhauser Verlag, Basel, Boston, Stuttgart.
Vol. 45 : Numerische Integration. Edited by G. Hammerlin. 1979. 320 pp. \$29.80.

These are the proceedings of an Oberwolfach conference of October 1978. There are 24 papers, of which 16 are in English, 8 in German. The emphasis is on the construction of best quadrature formulae, numerical integration of singular integral equations, Gauss quadrature, and numerical integration in n dimensions.

Vol. 46 : Numerische Methoden bei graphentheoretischen und kombinatorischen Problemen.
Vol. 2. Edited by L. Collatz, G. Meinardus, and W. Wetterling. 1979. 255 pp. \$32.50.

These are the proceedings of an Oberwolfach conference of May 1978. There are sixteen papers, half in English, half in German. The emphasis was on problems of complexity: the construction of effective polynomial algorithms and of useful approximate methods for NP-complete problems. Applications to mechanics, operations research, coding theory, computer networks and compiler construction were included.

Vol. 48 : Constructive methods for nonlinear boundary value problems and nonlinear oscillations. Edited by J. Albrecht, L. Collatz, and K. Kirchgassner. 1979. 190 pp. \$26.80.

These are the proceedings of an Oberwolfach conference of November 1978. The main theme of the conference was analytical and numerical procedures for the solution of nonlinear boundary value problems, whereby emphasis was placed on branching problems and their application to nonlinear oscillations. Some problems treated were: nonlinear wave propagation, nonlinear boundary value problems for the determination of plasma flows and their numerical treatment, numerical procedures for the solution of secondary bifurcation problems, and solution of oscillation equations of a chain with a "hard theorem" on implicit functions.

Optimization theory and applications. By S. S. Rao. Wiley Eastern Limited, New Delhi, Bangalore, Bombay, Calcutta, 1979. xiv + 711 pp.

This book gives a comprehensive and balanced treatment of the various optimization techniques. The development, application and computational aspects of linear, nonlinear, geometric, dynamic integer and stochastic programming techniques as well as classical optimization techniques, critical path method, program evaluation and review technique, game theory and calculus of variations are given. The book is oriented toward practical engineering applications and each new concept is illustrated by a numerical example. Some of topics which are potential areas for engineering application, such as integer nonlinear programming, stochastic programming and complementary geometric programming, are included in this book. It is designed to serve as a text for two courses of one semester each for students having a knowledge of differential calculus and matrix theory.

Numerical methods. By P. Rozsa. North-Holland, Netherlands, 1980. 620 pp. \$87.75.

These are the proceedings of the third Colloquium on Numerical Methods, organized by the Bolyai János Mathematical Society and held in Hungary in September 1977. The 42 papers cover the main areas of numerical mathematics; some are review papers with extensive references.

Mathematics of genetic diversity. By J. F. C. Kingman. Society for Industrial and Applied Mathematics, Philadelphia, 1980. vii + 70 pp. \$13.00.

This monograph is based on a set of lectures given at a conference at Iowa State University in June 1979 under the auspices of the Conference Board of the Mathematical Sciences and the National Science Foundation. The account concentrates on those aspects of the field which seem to the author both biologically relevant and mathematically interesting. There are four chapters; 1. The problem; 2. Survival of the fittest; 3. The neutral alternative; 4. Selection in finite populations.

Practical applications of symbolic computation. By James C. Howard. IPC Science and Technology Press, Surrey, England, 1980. xii + 394 pp. \$52.00.

The techniques described in this book represent an attempt to combine the power of tensor calculus, symbolic computation, and computer science to formulate mathematical models in a variety of Cartesian and curvilinear coordinate systems. The first chapter is concerned with those aspects of the tensor calculus that are considered necessary for an understanding of later chapters. The major part of the book is devoted to applications using the theory given in the first chapter. The applications are chosen to demonstrate the feasibility of combining tensor methods and computer capability to formulate problems of interest to students, engineers, and theoretical physicists. Chapter 2 is devoted to aeronautical applications that culminate in the formulation of a mathematical model of an aeronautical system. In chapter 3 the equations of motion of a particle are formulated in tensor form. The methods described in chapter 4 can be used to formulate mathematical models involving fluid dynamics. Cosmological applications are treated in chapter 5 and the final chapter describes how the symbol manipulation language MACSYMA may be used to assist in the formulation of mathematical models.

Elementary differential equations. 7th ed. By Earl D. Rainville and Phillip E. Bedient. The Free Press. (Division of Macmillan Publishing Co.), New York, 1980. xiv + 529 pp. \$21.95.

This is the seventh edition of the work first published in 1949. Some modest changes have been made.

A short course in differential equations. 6th ed. By Earl D. Rainville and Phillip E. Bedient. The Free Press (Division of Macmillan Publishing Co.), New York, 1980. xi + 335 pp. \$18.95.

This book contains the first sixteen of the twenty-six chapters of the text noted above. It thus omits discussion of infinite series and their application in the solution of differential equations.

A guide to econometrics. By Peter Kennedy. The MIT Press, Cambridge, Mass., 1979. xi + 175 pp. \$19.95 hardcover; \$7.95 paper.

This book is designed to be a supplement to econometrics texts, providing an overview of the subject and an intuitive feel for its concepts and techniques.

The decision problem: solvable classes of quantificational formulas. By Burton S. Dreben and Warren D. Goldfarb. Addison-Wesley, Reading, Mass., 1979. xii + 270 pp. \$27.50.

The authors address the logical decision problem by associating with each quantification formula a set, usually infinite, of quantifier-free formulas. They build on that approach to illuminate the mathematical structures underlying solvability, and provide a unified treatment of the positive results of the decision problem for quantification theory. The standard solvable classes are generalized, new solvable classes are obtained, and questions of the existence of finite models are investigated. Chapter headings: 0. Notation and the expansion theorem; 1. Basic considerations about expansions; 2. The amenability method; 3. Finite controllability; 4. The Maslov class; 5. Solvability without finite controllability; 6. Reductions; 7. Solvability and coinstantiations; 8. Schemata with identity; Appendix.

Stochastic processes and integration. By M. M. Rao. Sijthoff & Noordhoff International Publishers, The Netherlands, 1979. xi + 456 pp. \$55.00.

This book starts with the existence problems for real and vector stochastic processes and presents solutions based on the work of Kolmogorov, Bochner, Prokhorov and Gross. Conditional expectations and probabilities are treated as functional operators and vector measures together with some of their characterizations. Discrete martingales are discussed from the viewpoints of both Doob and Andersen & Jessen. Most of the book is devoted to continuous-parameter processes. Separability and measurability questions are treated for the separable and general range spaces, the latter with lifting theory. The lifting theory is presented from the differentiation method of Sion. Directed indexed martingales are included. The Doob-Meyer decomposition of submartingales and the consequent stochastic integration with the Kurita-Watanabe method are treated with a detailed analysis and compared with spectral integrals in Hilbert space. Extensions are given to local martingale and semimartingale integrals, and to measure representation, conformal martingales and multiparameter indexes. Markovian elements and diffusion are included. Additional material is given as complements and problems with detailed hints. Chapter headings: I. Introduction and foundations; II. Conditioning and martingales; III. Stochastic function theory; IV. Martingale analysis and integration.

Elementary linear algebra with applications. By Francis G. Florey. Prentice-Hall, Inc., Englewood Cliffs, N.J., 1979. xiii + 363 pp. \$14.95.

This is a first course in linear algebra at the sophomore level. Chapter headings: 1. Line vectors and coordinate vectors; 2. Coordinate geometry by vector methods; 3. Systems of linear equations and matrices; 4. Determinants; 5. Abstract vector spaces; 6. Linear transformations and matrices; 7. Eigenvalues, eigenvectors, and diagonal matrices; 8. Euclidean spaces. Answers are given to odd-numbered exercises.

General relativity and gravitation—one hundred years after the birth of Albert Einstein.

Edited by A. Held. Plenum Press, New York and London, 1980. Volume I, xvii + 540 pp; Volume II, xviii + 540 pp. \$57.50 each volume.

Volume I contains the following papers: 1. Einstein and the rigidly rotating disk; 2. Einstein's photon distribution for black bodies and the discovery of the laser; 3. Canonical gravity; 4. The Cauchy problem; 5. The positive mass conjecture; 6. The Hamiltonian structure of space-time; 7. The phase space formulation of general relativity and approaches toward its canonical quantization; 8. Quantum fields in curved space; 9. Fibre bundles, gauge fields, and gravitation; 10. Gravity, groups, and gauges; 11. Gravitation and the Poincaré gauge field theory and quadratic Lagrangian; 12. From gravity to supergravity; 13. The theory of separability of the Hamilton-Jacobi equation and its applications to general relativity; 14. Local isometric embedding of Riemannian manifolds and Einstein's theory of gravitation; 15. Invariant transformations, conservation laws and energy-momentum; 16. A review of algebraic computing in general relativity; 17. High-frequency gravitational waves, two-timing, and averaged Lagrangians; 18. Supergravity: an odyssey through space-time and superspace. Volume II contains the following papers: 1. Asymptotically flat space-times; 2. Asymptotic structure of the gravitational field at spatial infinity; 3. Angular momentum in general relativity; 4. Singularities and horizons—a review article; 5. Complex variables in relativity; 6. Complex general relativity; \mathcal{H} and \mathcal{H}/\mathcal{H} spaces—a survey of one approach; 7. Twistors for flat and curved space-time; 8. Cosmology; 9. Gravitational collapse to the black hole state; 10. Gravitational waves and their interaction with matter and fields; 11. The search for gravitational radiation; 12. Experimental tests of the general theory of relativity; 13. Progress in relativistic thermodynamics and electrodynamics of continuous media. From the preface: "Together with the decision to produce these volumes came the realization that one cannot hope to cover adequately all of the significant activities in general relativity even in two books devoted primarily to review articles. Quantitatively the research now covers too wide a front for that; qualitatively no one individual, even when writing on a specific topic, can hope to do justice to all the different attitudes toward the subject that exist within the community of relativists." The editors of these volumes have tried to present a work that represents a good number of the facets of the field.

Ring theory: proceedings of the 1978 Antwerp Conference (Lecture Notes in Pure and Applied Mathematics Series, Volume 51). Edited by F. Van Oystaeyen. 1979. Marcel Dekker, Inc., New York. 808 pp. \$45.00.

The original papers collected in this volume were presented at the NATO Advanced Study Institute on Ring Theory at the University of Antwerp, in August, 1978. Survey and introductory material has been omitted. The proceedings include (i) up-to-date results in P.I. theory, stemming from a particularly active period of research on this popular subject; (ii) fundamental papers on representation of artinian algebras over fields; and (iii) papers concerning localization theory and module theory.

Seepage and groundwater flow: numerical analysis by analog and digital methods. By K. R. Rushton and S. C. Redshaw. John Wiley & Sons, 1979. xii + 339 pp. \$45.00.

This is a volume in the Wiley series in geotechnical engineering. The authors show how the basic governing equations of porous flow can be solved by simple methods which, with minor modifications, can be applied to almost any problem in seepage and groundwater flow. These methods are shown to permit solutions to be obtained for both two- and three-dimensional problems in steady-state and time-variant situations.

The Monte Carlo methods in atmospheric optics. By G. I. Marchuk, G. A. Mikailov, M. A. Nazaraliev, R. A. Darbinjan, B. A. Kargin and B. S. Elepov. Springer Series in Optical Sciences, Vol. 12. Springer-Verlag, New York, 1980. viii + 208 pp. \$29.80

This monograph is devoted to questions of the theory and applications of the Monte Carlo method for solving problems of atmospheric optics and hydrooptics. The importance of these problems has grown because of the increasing need to interpret optical observations and to estimate radiative balance precisely for weather forecasting. Inhomogeneity and sphericity of the atmosphere, absorption in atmospheric layers, multiple scattering and polarization of light all create difficulties in solving these problems by traditional methods of computational mathematics. Particular difficulty arises when one must solve nonstationary problems of the theory of transfer of narrow beams that are connected with the estimation of spatial location and time characteristics of the radiation field. The radiative transfer process can be regarded as a Markov chain of photon collisions in a medium which result in scattering or absorption. The Monte Carlo technique consists in computational simulation of that chain and in constructing statistical estimates of the desired functionals. The chapter headings are: 1. Introduction; 2. Elements of radiative-transfer theory used in Monte Carlo methods; 3. General questions about the Monte Carlo technique for solving integral equations of transfer; 4. Monte Carlo methods for solving direct and inverse problems of the theory of radiative transfer in a spherical atmosphere; 5. Monte Carlo algorithms for solving nonstationary problems of the theory of narrow-beam propagation in the atmosphere and ocean; 6. Monte Carlo algorithms for estimating the correlation function of strong light fluctuations in a turbulent medium.

Dynamical systems and evolution equations; theory and applications. By J. A. Walker. Vol. 20 of The Series Mathematical Concepts and Methods in Science and Engineering. Plenum Press, New York, 1980. vii + 256 pp. \$29.50.

This book is primarily an exposition of certain methods of topological dynamics that have been found to be very useful in the analysis of physical systems but appear to be well known only to specialists. The purpose of the book is twofold: to present the material in such a way that the applications-oriented reader will be encouraged to apply these methods in the study of physical systems of personal interest, and to make the coverage sufficient to render the current research literature intelligible, preparing the more mathematically inclined reader for research in this particular area of applied mathematics. Chapter headings: 1. Evolution equations on \mathcal{A}^n ; 2. Preliminaries for abstract evolution equations; 3. Abstract dynamical systems and evolution equations; 4. Some topological dynamics; 5. Applications and special topics.

Annual review of fluid mechanics, vol. 12, 1980. Edited by Milton van Dyke, J. V. Wehausen and John L. Lumley. Annual Reviews, Palo Alto, 1980. 490 pp. \$20.00.

This volume contains the following papers: Some notes on the relation between fluid mechanics and statistical physics, by G. E. Uhlenbeck; Solitary waves, by John W. Miles; Topographically trapped waves, by Lawrence A. Mysak; Water transport in soils, by J.-Y. Parlange; Analysis of two-dimensional interactions between shock waves and boundary layers, by T. C. Adamson, Jr. and A. F. Messiter; Fluid mechanics of the duodenum, by Enzo O. Macagno and James Christensen; Dynamic materials testing: biological and clinical applications of network-forming systems, by Larry V. McIntire; Transonic flow past oscillating airfoils, by H. Tijdeman and R. Seebass; Scientific progress on fire, by Howard W. Emmons; Toward a statistical theory of suspension, by Richard Herczynisky and Izabella Pienkowska; Coastal circulation and wind-induced currents, by Clinton D. Winant; Instabilities of waves on deep water, by Henry C. Yuen and Bruce M. Lake; Stokeslets and eddies in creeping flow, by Hidenori Hasimoto and Osamu Sano; Continuous drawing of liquids to form fibers, by Morton M. Denn; Models of wind-driven currents on the continental shelf, by J. S. Allen; Particle motions in a viscous fluid, by L. G. Leal.

Multivariate analysis. Edited by P. R. Krishnaiah. Proceedings of the Fifth International Symposium on Multivariate Analysis. North-Holland Publishing Co., Amsterdam and New York, 1980. x + 677 pp. \$62.00.

This volume consists of invited papers presented at the Fifth International Symposium on Multivariate Analysis held at the University of Pittsburgh during the period June 19–24, 1978. In these papers, distinguished workers in the field from many countries discuss the current developments on a very broad spectrum of topics in the theory and applications of multivariate analysis. The topics covered include classification and pattern recognition, contingency tables, decomposition of multivariate probabilities, design and analysis of experiments, distribution theory, econometrics, estimation, limit theorems, multivariate analysis of variance, nonparametric methods, optimum properties of test procedures, psychometrics, random matrices, reduction of dimensionality, reliability, scaling methods, simultaneous test procedures, sociometry, statistical physics, stochastic control theory, and time series and stochastic processes.

Demand functions and the Slutsky matrix. By S. N. Afriat. Princeton University Press, Princeton, 1980. xii + 269 pp. \$16.50.

This is volume 7 of Princeton Studies in Mathematical Economics. The utility idea has had a long history in economics, especially in the explanation of demand and in welfare economics. In a comprehensive survey and critique of the Slutsky theory and its economic context, the author offers a resolution of questions central to its main idea. Chapter headings: 0. Introduction; 1. Slutsky's problem and the coefficients; 2. McKenzie's method; 3. Symmetry and negativity; 4. Utility contours and profiles; 5. De Finetti and convexification; 6. Slutsky and Samuelson; 7. Transitivity and integrability; 8. Slutsky and Frobenius; 9. Slutsky, finally.

Introduction to functional analysis. 2nd edition. By Augus E. Taylor and David G. Lay. John Wiley & Sons, New York, 1980. xi + 467 pp. \$23.95.

This is the second edition of a text first published in 1958 by one of the authors (A.E.T) Chapter headings: 1. The abstract approach to linear problems; 2. Topological linear spaces; 3. Linear functionals and weak topologies; 4. General theorems on linear operators; 5. Spectral analysis of linear operators; 6. Spectral analysis in Hilbert space; 7. Banach algebras.

Systems of linear inequalities. By A. S. Solodovnikov. University of Chicago Press, Chicago, 1980. viii + 81 pp. \$6.00.

A title in the paperback series "Popular Lectures in Mathematics". Table of contents: 1. Several facts from analytic geometry; 2. Geometric interpretation of a system of linear inequalities in two and three unknowns; 3. The convex hull of a point set; 4. Convex polyhedral cones; 5. The solution domain of a system of inequalities in two unknowns; 6. The solution domain of a system in three unknowns; 7. Systems of linear inequalities in an arbitrary number of unknowns; 8. Inconsistent systems; 9. Dual convex polyhedral cones; 10. The duality theory of linear programming.

The decomposition of figures into smaller parts. By Vladimir Grigor'evich Boltyanskii and Izrail' Tsudikovich Gohberg. Translated from the Russian by Henry Christoffers and Thomas P. Branson. University of Chicago Press, Chicago, 1980. vi + 74 pp. \$6.00.

A title in the paperback series "Popular Lectures in Mathematics." Chapter headings: 1. Division of figures into pieces of smaller diameter; 2. Division of figures in the Minkowski plane; 3. The covering of convex figures by reduced copies; 4. The problem of illumination.

Criteria for divisibility. By N. N. Vorob'ev. Translated and adapted from the Russian edition by Daniel A. Levine and Timothy McLarnan. University of Chicago Press, Chicago, 1980. ix + 69 pp. \$6.00.

A title in the paperback series "Popular Lectures in Mathematics". Chapter headings: 1. Divisibility of numbers; 2. The divisibility of sums and products; 3. Criteria for congruence and criteria for divisibility; 4. Divisibility of powers; 5. Proofs of theorems; 6. Solutions to problems.

Lectures on wave propagation. By G. B. Whitham. Springer-Verlag, New York, 1979. v + 148 pp. \$8.00.

These are the lecture notes of a course of lectures given at the T.I.F.R. Centre, Indian Institution of Science, Bangalore, in January and February 1978. The first three chapters provide basic background on the theory of characteristics and shock waves. The main content is an entirely new presentation. It is on water waves, with special emphasis on old and new results for waves on a sloping beach. This topic was chosen as a versatile one where a large number of the methods and techniques used in applied mathematics could be illustrated on a single area of application. The author also mentions the quite amazing results being found on exact solutions for the Korteweg-de Vries equation and related equations, in the form of the new approach developed by him and R. Rosales. Since the Korteweg-de Vries equation and its solutions originated in water wave theory, this seemed appropriate. Chapter headings: 1. Introduction to nonlinear waves; 2. Examples; 3. Shock waves; 4. A second-order system: shallow water waves; 5. Waves on a sloping beach: shallow water theory; 6. Full theory of water waves; 7. Waves on a sloping beach: full theory; 8. Exact solutions for certain nonlinear equations.

Stochastic processes and estimation theory with applications. By Touraj Assefi. John Wiley & Sons, New York, 1979. xi + 291 pp. \$23.50.

This book presents an introductory account of stochastic processes and estimation theory with applications. It is primarily intended for first-year graduate and advanced senior level students and practicing engineers and scientists whose work requires an acquaintance with the theory. The mathematical background assumed of the reader includes concepts of elementary probability theory, the ability to use Fourier and Laplace transforms, and an understanding of the basic ideas of linear system theory. Chapter headings: 1. Review of probability; 2. Stochastic processes; 3. Power spectrum of stationary processes; 4. Estimation theory; 5. Application of estimation theory to image restoration.