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OF  
APPLIED MATHEMATICS

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# 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.

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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 type-setter 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 (<sup>'</sup>), between alpha and  $\alpha$ , kappa and *k*, mu and *u*, nu and *v*, eta and  $\eta$ .

The level of subscripts, exponents, subscripts to subscripts, and exponents to exponents should be clearly indicated. Single embellishments over individual letters are allowed; the only embellishment allowed above groups of letters is the overbar.

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

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

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

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

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

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

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

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

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

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

**Figures:** Figures should be drawn in black ink with clean, unbroken lines; do not use ball point pen. The paper should be of a nonabsorbant quality so that the ink does not spread and produce fuzzy lines. If the figures are intended for reduction, they should be drawn with heavy enough lines so that they do not become flimsy at the desired reduction. The notation should be of professional quality and in proportion for the expected reduction size. Figures 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.



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*Perspectives of nonlinear dynamics*, Volume 2. By E. Atlee Jackson. Cambridge University Press, 1990. xvii+632 pages, \$59.50.

In this as in the first volume of a two-volume treatise, the perspectives of nonlinear dynamics generated by analytical, topological, and computational methods, and interplays between them, are developed in a variety of contexts. The book attempts to give an introductory presentation of these methods, and shows their use in the study of a broad spectrum of nonlinear dynamic systems. Some of the concepts considered are: topological equivalence; embeddings; dimensions and fractals; bifurcations and catastrophes; averaging methods; integrability; Poincaré maps and map-dynamics; empirical-computational sciences vis-à-vis mathematics; Ulam's synergetics, Turing's instability and dissipative structures; chaos; dynamic entropies; Lorenz and Rossler models; predator-prey and replicator models; Fermi-Pasta-Ulam and Kolmogorov-Arnold-Moser phenomena; solitons and nonsolitons; coupled maps and pattern dynamics; cellular automata. The areas in which these concepts appear include optics, geophysics, meteorology, hydrodynamics, plasma physics, accelerators, astrophysics, chemical dynamics, lattice dynamics, ecology, mathematical biology, electrical and mechanical systems. The presentation and style are such as to serve graduate students and research workers in a variety of fields as a first broad introduction to nonlinear dynamics. The text is complemented by a host of problems and copious references, extensive historical and bibliographic notes, exercises and examples, and appendices giving more details of some mathematical ideas. Each chapter includes an extensive section commentary on the exercises and their solution. The bibliography and references-by-topic section occupy together about 70 pages.

*Counting Processes and Survival Analysis*. By Thomas R. Fleming and David P. Harrington. John Wiley and Sons, 1991. xiii+429 pages, \$49.95.

This text is a volume in the Wiley Series in Probability and Mathematical Statistics. It explores the martingale approach to the statistical analysis of counting processes, with an emphasis on the application of those methods to censored failure time data. Both classical problems in asymptotic distribution theory for counting methods are investigated, as well as some newer methods for graphical analyses and diagnostics of censored data. The authors try to make the theoretical developments self-contained, and give much emphasis to the regression analysis of censored data. Students with one year of graduate study in statistics should find the presentation at an acceptable level. The prerequisite for the book is familiarity with a measure theoretic treatment of probability theory, and the development of the theory of counting processes, stochastic integrals, and martingales is provided to the extent needed in survival analysis. Chapter headings: 0. The applied setting; 1. The counting process and martingale framework; 2. Local square integrable martingales; 3. Finite sample moments and large sample consistency of tests and estimators; 4. Censored data regression models and their application; 5. Martingale central limit theorem; 6. Large sample results of the Kaplan-Meier estimator; 7. Weighted log rank statistics; 8. Distribution theory for proportional hazards regression.

*Heat Kernels and Spectral Theory*. By E. B. Davies. Cambridge University Press, 1991. ix+197 pages, \$24.95.

This advanced monograph, volume 92 of Cambridge Tracts in Mathematics, investigates the theory of linear, selfadjoint, second order, elliptic differential operators. Its goal is to investigate spectral properties and obtain pointwise bounds on eigenfunctions by studying the heat kernels, and relies entirely upon results proved within the last five years using quadratic form techniques and logarithmic Sobolev inequalities. These new techniques have led to radically better global bounds on the heat kernels. Chapter headings: 1. Introductory concepts; 2. Logarithmic Sobolev inequalities; 3. Gaussian bounds on heat kernels; 4. Boundary behavior; 5. Riemannian manifolds.

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*Directions in Robust Statistics and Diagnostics.* Edited by Werner Stahel and Sanford Weisberg. Springer-Verlag, 1991. Part I, xiii+252 pages, \$35.00; Part II, xiii+380 pages, \$45.00.

These are, respectively, volumes 33 and 34 of the IMA Volumes in Mathematics and Its Applications and the 39 papers contained in them are based on the proceedings of the first four weeks of the six-week IMA 1989 summer program "Robustness, Diagnostics, Computing and Graphics in Statistics", held at the Institute for Mathematics and Its Applications of the University of Minnesota. Robust procedures and diagnostic methods form two approaches to the general problem when the parametric model used for inference is not correctly specified. In the former, one seeks methods of inference that are rather insensitive to certain types of failure of the parametric model; in the latter, one conditions on the fit, using standard methods to attempt to diagnose incorrect assumptions, allowing the analyst to modify them and refit under the new set of assumptions. The papers in these volumes cover approaches to robust statistics and to diagnostics as well as overviews and presentations of specific methods for specific models. Much of both approaches finds its beginnings in the work of John W. Tukey, who points out in his presentation that the two methodologies are largely complementary. Many of the 28 papers concerned with *robustness* use the two best-known approaches, due respectively to Huber and Hampel. A more recent approach is described in a paper by Morgenthaler (see also the above review of the book *Configural Polysampling*). There is also a survey "Research Directions in Robust Statistics" by Stahel with an extensive reference list. Eleven papers are primarily concerned with *diagnostics*. Two contributions to the *interplay* between robustness and diagnostics are Tukey's "Graphical Displays for Alternate Regression Files" and the paper "Regression Diagnostics for Rank Based Methods" by McKean, Sheather, and Hettmansperger. An index is included at the end of each volume.

*Random Graphs '87.* Edited by Michal Karonski, Jerzy Jaworski, and Andrzej Rucinski. John Wiley and Sons, 1991. vii+368 pages, \$84.95.

This volume contains the Proceedings of the Third International Seminar on Random Graphs and Probabilistic Methods in Combinatorics, which was held in Poznan, Poland, June 27–July 3, 1987. The subject combines discrete mathematics, probability theory, and theoretical computer science. The 24 papers concern problems in random binomial graphs, regular and out-regular graphs, random mappings, trees and forests, graph enumeration, percolation theory, the theory of parallel computation, statistical testing, and the spread of information. The speakers hailed from Poland, Switzerland, Sweden, England, USA, Brazil, Germany, Canada, USSR, Japan, Bulgaria, Romania, and Czechoslovakia.

*Configural Polysampling—A Route to Practical Robustness.* Edited by Stephan Morgenthaler and John W. Tukey. John Wiley and Sons, 1991. xiv+228 pages, \$39.95.

This is a volume in the Wiley Series in Probability and Mathematical Statistics. It is its purpose to explain a *small sample theory of robustness* for invariant models. The editors cite the following unfamiliar ideas as being important in this collection of articles: 1. Expressing our *lack* of certainty about distribution shapes and related issues by selecting a few over-diverse alternatives and working with them (in part, through empirical sampling in finite samples); 2. Using different weighting schemes to convert a single set of samples into different sets of *weighted samples*, therefore allowing them to serve as "samples" from different populations (or different configurations). In addition to the editors, the authors and co-authors of the twelve articles are: Michael Cohen, Katherine Bell Krystinik, Fanny L. O'Brien, and George S. Easton. The mathematical level of the discussion is kept at a minimum so that most of the material can be read and understood on the basis of a solid introductory statistics course.

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*Perturbations—Theory and Methods.* By James A. Murdock. John Wiley and Sons, 1991. xvi+509 pages, \$54.95.

This text is a concise course in perturbation theory for the solution of algebraic and differential equations. With emphasis on ordinary differential equations, it covers all the methods commonly used in regular and singular perturbations, from Taylor series, Lindstedt series, strained parameters, to multiple scales, averaging, matching, and WKB methods. The nine chapters are divided into three groups, describing regular perturbation theory (Ch. 1–3), oscillatory phenomena (Ch. 4–6), and transition layer phenomena (Ch. 7–9). Chapter headings: 1. Root finding; 2. Regular perturbations; 3. Direct error estimation; 4. Periodic solutions and Lindstedt series; 5. Multiple scales; 6. Averaging; 7. Initial layers; 8. Boundary layers; 9. Methods of the WKB type.

*Time Series—A Biostatistical Introduction.* By Peter J. Diggle. Oxford University Press, 1990. xi+257 pages, \$75.00.

Whereas most introductory books on time-series analysis take their principal motivation either from economics, with a strong emphasis on forecasting methods, or from signal processing in engineering and the physical sciences, the motivation of the present author has been that of a statistician consulting in the biological sciences, and throughout the book, analyses of biological data sets are integrated into the methodological development. Chapter 1 introduces the basic concepts, and Chapter 2 covers simple descriptive methods of analysis, including plotting, smoothing, estimation of the covariance function, and the periodogram. Chapter 3 contains theoretical material on the properties of stationary random processes, and Chapter 4 develops the ideas of spectral analysis as essentially a nonparametric approach to the analysis of stationary time-series. Chapter 5 describes an alternative, parametric approach which is particularly appropriate for trend analysis. Chapter 6 considers the parametric approach for autoregressive integrated moving average (ARIMA) processes and in Chapter 7 results for ARIMA processes are incorporated into a discussion of forecasting. Chapter 8 is a brief introduction to the analysis of bivariate time series. Basic probability theory, statistical methods, matrix algebra, and calculus are assumed from the reader.

*A User's Guide to Principal Components,* By J. Edward Jackson. John Wiley and Sons, 1991. xvii+569 pages, \$69.95.

This is a volume in the Wiley Series in Probability and Mathematical Statistics. It is designed for practitioners of principal component analysis (PCA). It refers to appropriate works for the theoretical aspects of the method and also does not dwell excessively on computational techniques. The emphasis is on data reduction and interpretation. It is the purpose of the book to draw together existing information into a usable guide for practitioners of multivariate data analysis, and is also designed to be a sourcebook for principal components. The purpose of Chapters 5 and 9 is to bring together in a single example many of the techniques discussed in the preceding chapters. Chapter headings: 1. Getting started; 2. PCA with more than two variables; 3. Scaling of data; 4. Inferential procedures; 5. Putting it all together—hearing loss I; 6. Operations with groups of data; 7. Vector interpretation I: simplifications and inferential techniques; 8. Vector interpretation II: rotation; 9. A case history—hearing loss II; 10. Singular value decomposition: multidimensional scaling I; 11. Distance models: multidimensional scaling II; 12. Linear models I: regression; PCA of predictor variables; 13. Linear models II: analysis of variance; PCA of response variables; 14. Other applications of PCA; 15. Flatland: special procedures for two dimensions; 16. Odds and ends; 17. What is factor analysis anyhow? 18. Other competitors.

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*Differential Equations—A Dynamical Systems Approach; Part I: Ordinary Differential Equations.* By John H. Hubbard and Beverly H. West. Springer-Verlag, 1991. xviii+348 pages, \$39.00.

This is volume 5 in the series Texts in Applied Mathematics. It is an introduction to ordinary differential equations, stressing the significance and importance of the qualitative theory for a full understanding; it is to be followed by Part II: Higher Dimensional Differential Equations, and Part III: Partial Dimensional Differential Equations. It is designed for a junior-senior level course. To accompany it, the authors have developed a software package for the Macintosh called MacMath, which includes *Analyzer, DiffEq, NumMeths, Cascade, 1D Periodic Equations*, and refer to it throughout the text. Chapter headings: 1. Qualitative theory; 2. Analytic methods; 3. Numerical methods; 4. Fundamental inequality, existence, and uniqueness; 5. Iteration. The "fundamental inequality" in Chapter 4 builds on a version given in Jean Dieudonné's calculus text, giving, by a constructive proof, existence and uniqueness of solutions and providing error estimates.

*Continuum Models and Discrete Systems.* Edited by G. A. Maugin. Longman Scientific & Technical, and John Wiley & Sons, 1990. Volume I, 324 pages, \$150.00; Volume II, 364 pages, \$140.00.

These are the proceedings of the Sixth International Symposium on Continuum Models and Discrete Systems, held at the University of Bourgogne, Dijon, France, from June 25 to June 29, 1989. Volume I contains forty of the short contributions, and volume II twenty of the invited lectures, all divided into groups according to the four broad themes that had been selected for the Symposium: 1. Complex fluids; 2. Deformable solids with microstructure; 3. Microstructure, thermodynamics and geometry; 4. Non-linear excitations and coherent structures. These topics cover many effects in material science and modern phenomenological physics, and foster the development of new appropriate techniques in applied mathematics such as cell automata theory, asymptotic and stochastic homogenization techniques, techniques in non-linear dispersive wave theory, thermodynamically admissible geometrical approaches (e.g., Hamiltonian structures, gauge theories, Lie pseudo-groups), coherent structures due to scale effects and the combination or competition of these with other effects yielding, for instance, the propagation of non-linear waves of permanent form and the striking time evolution of some patterns.

*Sampling of Populations: Methods and Applications.* By Paul S. Levy and Stanley Lemeshow. John Wiley and Sons, 1991. xxiii+420 pages, \$49.95.

This is a volume in the Wiley Series in Probability and Mathematical Statistics. The original edition of this text was published in 1980 by Lifetime Learning Publications under the title *Sampling for Health Professionals*. The present volume is a product of considerable expansion and revision of this earlier work, taking into consideration major developments in sampling methodology over the past decade. Chapter headings: 1. Use of sample surveys; 2. The population and the sample; 3. Simple random sampling; 4. Systematic sampling; 5. Stratification; 6. Stratified random sampling; 7. Ratio estimation; 8. Cluster sampling: introduction and overview; 9. Simple one-stage cluster sampling; 10. Simple two-stage cluster sampling; 11. Cluster sampling from clusters having unequal numbers of listing units; 12. Variance estimation in complex sample surveys; 13. Nonresponse and missing data in sample surveys; 14. Selected topics in sample design and estimation methodology; 15. Constructing forms and collecting data in sample surveys; 16. Interpretation of data and survey report writing.

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*Stationary Stochastic Models.* By Andreas Brandt, Peter Franken, and Bernd Lisek. John Wiley and Sons, 1990. 344 pages, \$89.95.

This is a volume in the Wiley Series in Probability and Mathematical Statistics. The authors, members of the Humboldt University in Berlin, provide a general and unified approach for treating basic problems in modelling stochastic systems, using recursive stochastic equations and marked point processes. Applications include queueing systems, Markov chains, linear filters and robust filters for time series, as well as performance evaluation of systems and manufacturing procedures in development engineering. Chapter headings: 1. Recursive stochastic equations  $X_{n+1} = f(X_n, U_n)$ ; 2. The case of i.i.d.  $U_n$ : stationary Markov chains; 3. Stationary sequences and stationary marked point processes; 4. Continuous time models; 5. Arrival-stationary queueing processes. Existence and uniqueness. 6. Relationships between arrival-, time-, and departure-stationary queueing processes; 7. Batch-arrival-stationary queueing processes; 8. Continuity of queueing models; 9. Further models.

*Conditioning Diagnostics—Collinearity and Weak Data in Regression.* By David A. Belsley. John Wiley and Sons, 1991. xx+396 pages, \$59.95.

This monograph, a volume in the Wiley Series in Probability and Mathematical Statistics, is a new version of *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity* by David A. Belsley, Edwin Kuh, and Roy E. Welsch, integrating a complete revision of the original material with research published in the intervening decade. Also, background material and data sets have been added. The result is a nearly self-contained treatment of the problems of ill-conditioning and data weaknesses as they affect the least-squares estimation of the linear model along with extensions to nonlinear models and simultaneous equations estimators. Chapter headings: 1. Introduction and overview; 2. Collinearity; 3. A collinearity diagnostic; 4. The experimental experience; 5. Summarizing and interpreting the collinearity diagnostics; 6. Data and model considerations; 7. Harmful collinearity and short data; 8. Collinearity-influential observations; 9. Collinearity diagnostics in models with logarithms and first differences; 10. Corrective action and case studies; 11. General conditioning and extensions to nonlinearities and simultaneity.

*Functional Analysis.* By Frigyes Riesz and Béla Sz.-Nagy. Dover Publications, 1990. 480 pages. \$11.95.

This translation, by Leo F. Boron, of the second French edition, is an unabridged republication of the work first published by Frederick Ungar Publishing Co. in 1955. The first French edition is from 1952. The appendix, separately published by Ungar in 1960, has been added to this edition. The book developed from courses the authors had taught for several years at the Universities of Szeged and Budapest. It is in two parts: I. Modern theories of differentiation and integration (Chapters 1–3); II. Integral equations and linear transformations (Chapters 4–11). Chapter headings: 1. Differentiation; 2. The Lebesgue integral; 3. The Stieltjes integral and its generalizations; 4. Integral equations; 5. Hilbert and Banach spaces; 6. Completely continuous symmetric transformations of Hilbert space; 7. Bounded symmetric, unitary, and normal transformations of Hilbert space; 8. Unbounded linear transformations of Hilbert space; 9. Self-adjoint transformations. Functional calculus, spectrum, perturbations; 10. Groups and semigroups of transformations; 11. Spectral theories for linear transformations of general type. Appendix: Extensions of linear transformations in Hilbert space which extend beyond this space.

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*Programming in Martin-Löf's Type Theory—An Introduction.* By Bengt Nordström, Kent Petersson, and Jan M. Smith. Oxford University Press, 1990. x+221 pages.

This is volume 7 in the International Series of Monographs on Computer Science. It describes different type theories (theories of types, polymorphic and monomorphic sets, and subsets) from a computing science perspective. It is intended for researchers and graduate students with an interest in the foundations of computing science, and it is mathematically self-contained.

*Finite Geometries, Buildings, and Related Topics.* Edited by William M. Kantor, Robert A. Liebler, Stanley E. Payne, and Ernest E. Shult. Oxford University Press, 1990, xii+159 pages.

These are the proceedings of a conference held July 17–23, 1988, at Pingree Park, Colorado. The original purpose of the introduction of the theory of buildings by Jacques Tits was to provide an understanding of the analogues of the simple Lie groups, and particularly the exceptional groups, over an arbitrary field. The contributions to these proceedings have been ordered so as to begin with an introduction to various aspects of the theory, followed by papers gradually spreading out to more wide-ranging areas of geometry.

*The Construction Theory of Denumerable Markov Processes.* By Xiang-Qun Yang, with a foreword by D. G. Kendall. John Wiley and Sons, 1990. xiii+395 pages, \$95.00.

This is a volume in the Wiley Series in Probability and Mathematical Statistics. It is an English translation (by the author) of the second (1984) edition of a monograph first published in China in 1981. The author presents the theory of temporally-homogeneous countable-state Markov chains developing in continuous time. The basic framework of the theory of such Markov chains is first set out, and the latter chapters develop more recent advanced work by the author and by some other Chinese scholars. The first chapter develops the theoretical background and the remaining 14 chapters are divided into six parts, entitled: 1. General construction theory; 2. Construction theory of birth-death processes; 3. Martin boundary and its application in the construction theory; 4. Path structure of denumerable Markov processes; 5. Construction theory of birth-death processes: Probability method; 6. Properties of Markov processes related to construction theory.

*Spectral and Scattering Theory for Wave Propagation in Perturbed Stratified Media.* By Ricardo Weder. Springer-Verlag, 1991. 188 pages, \$39.00.

This is volume 87 in the series Applied Mathematical Sciences. It presents a complete and self-contained study of acoustic and electromagnetic wave propagation in perturbed stratified media from the point of view of modern constructive stationary spectral and scattering theory. Many of the results are published here for the first time. After an introduction in Chapter 1, Chapter 2 studies the case of propagation of acoustic waves in a perturbed Pekeris velocity profile. Chapter 3 presents the case of electromagnetic wave propagation in three-dimensional dielectric wave guides, described by the vector Maxwell system of equations. There are two appendices presenting results used in the previous chapters.



*Linear Multivariable Control—Algebraic Analysis and Synthesis Methods.* By A. I. G. Vardulakis. John Wiley and Sons, 1991. xi+369 pages, \$125.00.

The aim of this volume is to provide a rather detailed account of the basic theory of polynomial and fractional representation methods for the algebraic analysis and synthesis of linear multivariable control systems. It was the author's intention to put under one cover a self-contained exposition of the mathematical theory in such a way that results and techniques of the state-space approaches for regular and singular systems appear as special cases of a general theory covering the wider class of polynomial matrix descriptions of linear systems.

Chapter headings: 1. Real rational vector spaces and rational matrices; 2. Polynomial matrix models of linear multivariable systems; 3. Pole and zero structure of rational matrices at infinity; 4. Dynamics of polynomial matrix models; 5. Proper and  $\Omega$ -stable rational functions and matrices; 6. Feedback system stability and stabilization; Some algebraic design problems.

*Statistics for Research*, Second edition. By Shirley Dowdy and Stanley Wearden. John Wiley and Sons, 1991. xvii+629 pages, \$49.95.

This is a volume in the Wiley Series in Probability and Mathematical Statistics. For this second edition of a text first published in 1982 computer output in SAS has been included for each of the statistical procedures discussed, including also the programs necessary to obtain this output. Also, procedures of nonparametric statistics have been included in this edition. In addition, the chapter on multiple regression has been considerably revised and brought up-to-date. As before, the textbook is designed for a two-semester introductory statistical methods course for graduate students who have no prior background in statistics but will need to use the material in natural and social science research.

*The Structure of the Proton—Deep Inelastic Scattering.* By R. G. Roberts. Cambridge University Press, 1991. vii+182 pages, \$49.50.

This graduate/research level book, a volume of the Cambridge Monographs on Mathematical Physics, describes our present knowledge of protons and neutrons. The strong forces that bind together the quarks—point-like constituents of the proton—are described in terms of the modern theory of quantum chromodynamics (QCD), the “glue” binding the quarks being mediated by new constituents called gluons. The subject of the book is deep inelastic scattering by leptons off a nucleon target. Chapter headings: 1. Introduction; 2. Structure functions; 3. Quark parton model; 4. Perturbative QCD; 5. Applying QCD to deep inelastic scattering; 6. Large and small  $x$ ; 7. The parton distributions; 8. Quarks and gluons in nuclei—structure of the bound nucleon.

*General Relativity and Gravitation 1989.* Edited by Neil Ashby, David F. Bartlett, and Walter Wyss. Cambridge University Press, 1991. xvii+502 pages, \$49.50.

These are the Proceedings of the 12th International Conference on General Relativity and Gravitation, held at the University of Colorado, Boulder, July 2–8, 1989. The talks are divided into five groups: A. Classical relativity and gravitation theory; B. Relativistic astrophysics, early universe, and classical cosmology; C. Experimental gravitation and gravitational wave detection; D. Quantum gravity, superstrings, quantum cosmology; E. Overviews—past, present, and future. Each part contains texts of the invited lectures and reports on the workshop presentations.

*Reliable Numerical Computation.* Edited by M. G. Cox and S. Hammarling. Oxford University Press, 1991. xvi+339 pages, \$75.00.

This is a volume in the series Oxford Science Publications. It is the proceedings of a conference held in honour of the memory of James Hardy Wilkinson, FRS, who died on 5 October 1986. For this conference, held at the National Physical Laboratory, research papers were invited from twenty of the world's best-known numerical mathematicians in the areas of linear algebra, error analysis, computer arithmetic, and mathematical software, in all of which Wilkinson had made many distinguished contributions. In addition, G. H. Golub was invited to speak about Wilkinson's influence on his fellow researchers and L. Fox to give personal reminiscences. These two talks as well as the seven talks on linear algebra, eight talks on error analysis and computer arithmetic, and three talks on mathematical software are all included in this volume.

*General Relativity—An Introduction to the Theory of the Gravitational Field.* Second edition. By Hans Stephani, edited by John Stewart, translated by Martin Pollock and John Stewart. Cambridge University Press, 1990. xiv+321 pages, \$64.50 cloth, \$29.95 paper.

This book is a translation of the first (1977) edition with all of the amendments and corrections of the second (1980) and third (1988) editions included. Further, the bibliography has been updated to 1987/88, and where possible English translations have been cited. The text is designed to provide an introduction to the foundations of Einstein's theory and also to survey the questions it raises, its concepts and its methods. The reader is assumed to be familiar with theoretical mechanics, electrodynamics, and special relativity. The necessary basic ideas of Riemannian geometry are described in the second chapter. Chapter headings: 1. Introduction; 2. Foundations of Riemannian geometry; 3. Foundations of Einstein's theory of gravitation; 4. Linearized theory of gravitation, far fields and gravitational waves; 5. Invariant characterization of exact solutions; 6. Gravitational collapse and black holes; 7. Cosmology; 8. Non-Einsteinian theories of gravitation.

*Modern Algebra.* By Seth Warner. Dover Publications, 1990. 832 pages. \$16.95.

This is an unabridged, corrected republication in one volume of the work originally published in two volumes by Prentice-Hall, Inc., in 1965. It is written for junior and senior undergraduates, and suitable for graduate students unprepared in modern algebra. It opens with a study of algebraic structures in general. The first part then carries the development from natural numbers through rings and fields, vector spaces, and polynomials. The second part (originally published as a separate volume) is made up of five chapters on the real and complex number fields, linear operators, inner product spaces, and the axiom of choice. There are over 1300 exercises.

*Introduction to Topology,* Third Edition. By Bert Mendelson. Dover Publications, 1990. 224 pages. \$5.95.

This is an unabridged, unaltered republication of the work originally published by Allyn and Bacon, Inc., in 1975 (first edition 1962, second edition 1968). Originally prepared from lecture notes used at Smith College, it is directed to undergraduate students who have had a calculus sequence in which some attention has been paid to definitions and proofs of theorems.

*Computers in Mathematics.* Edited by David V. Chudnovsky and Richard D. Jenks. Marcel Dekker, 1990. 432 pages. \$89.75

This is volume 125 in the series Lecture Notes in Pure and Applied Mathematics. It is derived from talks delivered at the International Conference on Computers and Mathematics, held at Stanford University July 29–August 1, 1986. Some of the invited talks focused on the past and future roles of computers as a research tool in such areas as number theory, analysis, special functions, combinatorics, algebraic geometry, topology, physics, mathematical physics, and other fields. Other talks described the role of mathematics in fields that evolved from the presence of computers, such as numerical analysis, artificial intelligence, computer algebra, and theoretical computer science. The keynote remarks were given by Edward E. David.

*Chaos and Socio-Spatial Dynamics.* By Dimitrios S. Dendrinos and Michael Sonis. Springer-Verlag, 1990. xvi + 184 pages. \$39.80.

This is volume 86 in the series Applied Mathematical Sciences. Its main objective is to present some key qualitative features of a universal discrete relative dynamics map (iterative process). It is argued that the form of this map can accommodate a wide range of dynamics found in social systems distributed in discrete space. Particular emphasis is placed on population dynamics. The models included in the book are apparent from the table of contents: 1. Socio-spatial dynamics; 2. One stock, two regions; 3. One stock, multiple locations; 4. Multiple stocks, multiple locations. It is shown that the qualitative properties of the dynamics vary significantly as one spans the spectrum of the models studied.

*A Statistical Model: Frederick Mosteller's Contributions to Statistics, Science, and Public Policy.* Edited by S. E. Fienberg, D. C. Hoaglin, W. H. Kruskal, and J. M. Tanur. Springer-Verlag, 1990. xviii + 283 pages. \$39.00.

This is a volume in the Springer Series in Statistics. It was compiled to honor Frederick Mosteller on the occasion of his 70th birthday. It consists of the following chapters: 1. Biography, by John W. Tukey; 2. Bibliography; 3. Contributions as a scientific generalist, by William Kruskal; 4. Contributions to mathematical statistics, by Persi Diaconis and Erich Lehmann; 5. Contributions to methodology and applications, by Stephen E. Fienberg; 6. Fred as educator, by Judith M. Tanur; 7. Fred at Harvard, by Stephen E. Fienberg and David C. Hoaglin; 8. Reviews of book contributions, edited by David C. Hoaglin.

*Object Recognition by Computer—The Role of Geometric Constraints.* By W. Eric L. Grimson, with contributions from Tomàs Lozano-Pèrez and Daniel P. Huttenlocher. The MIT Press, 1991. xv+512 pages, \$45.00.

This volume in the MIT Press Series in Artificial Intelligence describes an extended series of experiments on the role of geometry in the critical area of object recognition. It provides precise definitions of the recognition and localization problems, describes the methods used to address them, analyzes the solutions to these problems, and addresses the implications of this analysis. The authors provide a framework for understanding both the strengths and limitations of using object shapes to guide recognition.

*Mathematical Methods in Kinetic Theory*, Second Edition. By Carlo Cercignani. Plenum Press, 1990. xi + 252 pages. \$39.50.

This is a revised edition of the book first published in 1969. Literature has been updated and an introduction is also given to the important developments concerning the purely mathematical theory (existence and uniqueness theorems), since this part of kinetic theory has reached a mature stage in the last few years and is relevant for both the physical foundations of the subject (validity of the Boltzmann equations) and the application of kinetic theory to rarefied gas dynamics. The headings of the eight chapters are: 1. Basic principles; 2. Basic properties; 3. The linearized collision operator; 4. Model equations; 5. The Hilbert and Chapman-Enskog theories; 6. Basic results on the solutions of the Boltzmann equation; 7. Analytic methods of solution; 8. Other methods of solution.

*Combinatorial Algorithms for Integrated Circuit Layout*. By Thomas Lengauer. B. G. Teubner, Stuttgart, and John Wiley and Sons, 1990. xxviii + 697 pages. \$59.95.

This is a volume in the series *Applicable Theory in Computer Science*. The two difficult aspects of building a layout system are the combinatorial aspect and the systems aspect. This book deals only with the former, which labors under the difficulty that most of the optimization problems that have to be solved during integrated-circuit layout are intractable since they are usually NP-hard or harder. The purpose of this book is to give an overview of these problems and to describe their solutions. The author discusses algorithms used in layout systems today, as well as new algorithmic developments that as of now only exist as theoretical proposals but that bear some promise of stimulating the improvement of layout systems in the future.

*Truth and Modality for Knowledge Representation*. By Raymond Turner. The MIT Press, 1991. 119 pages, \$25.00.

This volume in the MIT Press Series in Artificial Intelligence puts current research in theories of truth and modality in a context where it can be directly applied to knowledge representation in Artificial Intelligence. The goal is to help AI researchers understand how the intelligent agents they are developing represent and reason about what they believe, know, and hold to be true.

*Modern Multivariate Statistical Analysis: A Graduate Course and Handbook*. By Minoru Siotani, Takesi Hayakawa, and Yasunori Fujikoshi. American Science Press, Inc., 1995. xiv+759 pages, \$98.75.

This is a volume in the American Series in Mathematical and Management Sciences. It aims to give a reader who has already taken a multivariate methods course, a sound theoretical basis of modern multivariate analysis. Chapter headings: 1. Multivariate normal and some other distributions; 2. Wishart distribution and functions of Wishart matrices; 3. Regressions, correlations and their distributions; 4. Useful asymptotic expansion formulas; 5. Inference on mean vector and Hotelling's statistic; 6. Multiple comparisons on mean vectors; 7. Multivariate regression and the linear model; 8. Inference on covariance matrices; 9. Discriminant analysis; 10. Distributions of characteristic roots and vectors; 11. Principal component analysis; 12. Canonical correlation analysis; 13. Selection of variables. There are appendices on matrix results and on specific computer programs and a forty-page bibliography of references cited in the text.