

QUARTERLY
OF
APPLIED MATHEMATICS

EDITED BY

H. W. BODE
P. J. DAVIS
E. T. ONAT

J. L. SYNGE
G. F. CARRIER
D. C. DRUCKER

HIRSH COHEN
U. GRENANDER
P. S. SYMONDS
H. T. BANKS

W. F. FREIBERGER, *Managing Editor*

EDITED WITH THE COLLABORATION OF

M. A. BIOT
C. FERRARI
G. E. HAY
E. REISSNER
J. J. STOKER

J. M. BURGERS
P. GERMAIN
P. LE CORBEILLER
S. A. SCHELKUNOFF

H. W. EMMONS
J. A. GOFF
F. D. MURNAGHAN
W. R. SEARS

FOUNDER, AND
MANAGING EDITOR 1943-1965
W. PRAGER

VOLUME XXXV

OCTOBER • 1977

NUMBER 3

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, 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 \$25.00 per page which, if honored, entitles them to 100 free reprints. Instructions will be sent with galley proofs.

The 1977 subscription price for Volume 35 (April 1977–January 1978) is \$25.00. Single issues can be purchased, as far as they are available, at \$8.00 and back volumes at \$25.00 per volume. Subscriptions and orders for back volumes must be addressed to: American Mathematical Society, P.O. Box 1571, Providence, R. I. 02901. All orders must be accompanied by payment. Other subscription correspondence should be addressed to American Mathematical Society, P.O. Box 6248, Providence, R. I. 02940.

Second-class postage paid at Providence, Rhode Island, and at Richmond, Virginia
Publication number 808680

WILLIAM BYRD PRESS, INC., RICHMOND, VIRGINIA

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.

CONTENTS

W. B. CASTELAN AND E. F. INFANTE: On a functional equation arising in the stability theory of difference-differential equations	311
LIM CHEE-SENG: A radiation-condition Gaussian induced MGD cone field	321
N. ANDERSON AND A. M. ARTHURS: Dual extremum principles for heat-transfer problems with variable thermal properties	337
D. H. MICHAEL: Nonlinear effects in electrohydrodynamic surface wave propagation	345
P. GATIGNOL: Two-timing procedure for higher-order modulations of near-linear dispersive wave trains with an application to plasma waves .	357
NIMA GEFFEN: A variational formulation for constrained quasilinear vector systems	375
JOHN MALLET-PARET: Buckling of cylindrical shells with small curvature	383
NOTES:	
L. M. KEER AND K. S. PARIHAR: Singularity at the apex of pyramidal notches with three equal angles	401
CORNELIUS O. HORGAN AND LEWIS T. WHEELER: Isoperimetric inequalities for the Dirichlet eigenvalue problem	406
WAN-LEE YIN: Zone estimates in the elastic-plastic torsion problem	410
BOOKS RECEIVED	320, 336, 344, 356, 374, 382, 415

—BOOKS RECEIVED—

Notice in this section does not preclude later full review in the Book Review Section.

Vector analysis. By N. Kemmer. Cambridge University Press, New York, London, Melbourne, 1977. xiv + 254 pp. \$28.50 hardcover; \$8.95 paperback.

This book is subtitled "A physicist's guide to mathematics of fields in three dimensions" which well describes the purpose of this rather novel presentation.

Function of several variables. By Wendell Fleming. Springer-Verlag, New York-Heidelberg-Berlin, 1977. xi + 411 pp. \$16.80.

This is the second edition of a volume in the series 'Undergraduate Texts in Mathematics'. It gives a systematic development of differential and integral calculus for functions of several variables. It differs from traditional treatments in several respects. Vector notation is used throughout; the elements of the Lebesgue theory of integrals is given; in place of vector analysis in E^3 , exterior algebra and the calculus of exterior differential forms are introduced. Among changes from the first edition is a new chapter on elementary topology, additional physical applications, and some easier proofs.

Nonlinear diffusion problems. By O. Diekmann and N. M. Temme. Stichting Mathematisch Centrum, Amsterdam, 1976. viii + 247 pp. Dfl. 30.

This volume 28 in 'Mathematisch Centrum Syllabus' represents a series of lectures delivered at the Center. The idea of the series was to present background material on the qualitative analysis of parabolic partial differential equations, and subsequent developments. The biological background of some mathematical questions is given; the maximum principle is introduced and used extensively; the basic theory of Lyapunov functions for dynamical systems is presented and applied to parabolic initial-boundary value problems; and other relevant topics are surveyed.

A theoretical and computational study of generalized aliquot sequences. By H. J. J. Te Riele. Stichting Mathematisch Centrum, Amsterdam, 1976. x + 76 pp. Dfl.10.

This is Mathematical Centre Tract #74. Aliquot sequences are defined thus: a leading term is given and every subsequent term is the sum of the 'aliquot parts' of the preceding term. The aliquot parts of a number > 1 are all divisors (including 1) less than that number. These sequences were studied by Pythagoras, Euler, Catalan, Dickson and others.

Mechanics today, vol. 3. Ed. S. Nemat-Nasser. Pergamon Press, Oxford, Elmsford, New York, 1976. xxii + 306 pp. \$30.00.

This survey contains the following articles: on modelling the dynamics of composite materials; the analysis of elastodynamic crack tip stress fields; random vibration of periodic and almost periodic structures; integral representations and the Oseen flow problem; on nonlinear gyroscopic systems; application of the WKB method in solid mechanics.

(continued on page 336)

(continued from page 320)

Molecular symmetry and group theory. By Alan Vincent. John Wiley and Sons, New York, 1977. x + 156 pp. \$13.50 cloth, \$5.95 paper.

This is a programmed introduction to chemical applications of the title subject.

Chess skill in man and machine. Edited by Peter W. Frey. Springer-Verlag, New York, Heidelberg, Berlin, 1977. xi + 217 pp. \$14.80.

A collection of articles by various hands on: computer chess tournaments 1970-75; human chess skill; computer chess; search strategies in chess; heuristic search; man and machine; and various particular chess programs.

The uncertainty principle and foundations of quantum mechanics. A fifty years' survey. Edited by W. C. Price and S. S. Chissick. John Wiley & Sons, New York, 1977. xvii + 572 pp. \$42.00.

This book commemorates the formulation of quantum (or matrix) mechanics by Heisenberg in 1925. It contains articles by eminent authorities on topics associated with various aspects of Heisenberg's work. They are collected into 4 groups dealing with: uncertainty relations, their history and philosophical implications on causality; measurement theory; formal quantum theory; applied quantum mechanics.

Statistical and computational methods in data analysis. By Siegmund Brandt. North-Holland, Amsterdam, New York, 1976. xviii + 416 pp. \$35.95.

This is the second, revised edition of the book first published in 1970. Additions include sections on the Monte Carlo method and time series analysis.

Probability methods in oil exploration. By John W. Harbaugh, John H. Doveton, and John C. Davis. John Wiley & Sons, New York, 1977. xi + 269 pp. \$18.95.

This book describes statistical methods for quantitatively estimating outcome probabilities that involve the systematic and objective use of geological information.

Vector fields. By J. A. Shercliff. Cambridge University Press, Cambridge, London, New York, Melbourne, 1977. xi + 329 pp. \$28.50 hardcover, \$7.95 paperback.

The book is subtitled 'Vector analysis developed through its application to engineering and physics' which summarizes its thrust.

Integral equations. By B. L. Moiseiwitsch. Longman Inc., New York, 1977. ix + 161 pp. \$9.50.

This book is mainly concerned with linear integral equations, proving results for square integrable functions. Hence, for the most part, the distinction between Riemann and Lebesgue integration disappears and makes the book suitable for a wider class of readers. Two chapters deal with Hilbert space and linear operators in it. Fredholm and Hilbert-Schmidt theory are covered.

(continued on page 344)

(continued from page 336)

Nonlinear programming. Analysis and methods. By Mordecai Avriel. Prentice-Hall, New Jersey, 1977. xv + 512 pp. \$24.95.

Part I derives optimality conditions and discusses convex programming, duality, generalized convexity and analysis of selected nonlinear programs. Part II deals with techniques for numerical solutions, treats unconstrained optimization methods, and presents widely used, recently developed and promising algorithms for constrained nonlinear optimization problems.

Computing methods in applied sciences. Ed. R. Glowinski and J. L. Lions. Springer-Verlag, Berlin, Heidelberg, New York, 1976. 593 pp. \$15.20.

This book contains part of the lectures presented at the Second International Symposium on Computing Methods in the Applied Sciences and Engineering, December 15–19, 1975, organized by the Institut de Recherche d'Informatique et d'Automatique. The remaining lectures are published as Lecture Notes in Economics and Mathematical Systems, Volume 134. The section headings are: generalities; non-linear problems and finite elements; meteorology; oceanography; fluid mechanics.

Supersonic flow and shock waves. R. Courant and K. O. Friedrichs. Springer-Verlag, New York, Heidelberg, Berlin, 1976 ed. xvi + 464 pp.

This is volume 21 in the series 'Applied Mathematical Sciences' and represents an unchanged reprint of the well-known monograph first published in 1948, which itself originated from a report issued in 1944 under the auspices of the Office of Scientific Research and Development.

The theory of unitary group representations. By George W. Mackey. Univ. of Chicago Press, Chicago, 1976. x + 372 pp. \$4.95.

A volume in the Chicago Lectures in Mathematics, based on lectures given at the University of Chicago in 1955 which have been available in mimeographed form. The notes are only slightly revised, but nearly half the book (164 pp.) is occupied by an appendix sketching the developments which have taken place between 1955 and 1975 as well as the early history of the subject. At the end of the appendix there is a bibliography of 356 items, supplementing the bibliography in the author's 1961 American Mathematical Society Colloquium lectures (Bull. A.M.S. 69, 1963, 628–686).

The Moscow puzzles, 359 mathematical recreations. By Boris A. Kordemsky. Edited by Martin Gardner. Charles Scribner's Sons, New York, 1977. viii + 309 pp. \$4.95 paperback.

This book is the first English translation of "Mathematical Know-how"—what Martin Gardner calls the best and most popular puzzle book ever published in the Soviet Union; it sold a million copies in the Russian version, and there are translations into the languages of Bulgaria, Rumania, Hungary, Czechoslovakia, Poland, Germany, France, China, Japan and Korea.

Introduction to ergodic theory. By Ya. G. Sinai. Translated by V. Scheffer. Princeton University Press, New Jersey, 1977. 144 pp. \$6.00.

This volume in the Mathematical Notes series was originally published in Russian in 1973. The lectures on which it is based were addressed to what the author calls "pedestrians": non-specialist students, who did not want a rigorous treatment of the subject. There are few proofs of general theorems based on a serious application of measure theory, but many examples.

(continued on page 356)

(continued from page 344)

Graphs, surfaces and homology: an introduction to algebraic topology. By P. J. Giblin. Halsted Press, New York, 1977. xv + 329 pp. \$10.50 paper.

An undergraduate text, assuming only a knowledge of elementary linear algebra. The emphasis is on low-dimensional examples (graphs and surfaces). There are digressions into planar graphs, Kirchhoff's laws, minimal triangulations, embedding and coloring problems, etc., and many examples.

Introductory biostatistics for the health sciences. By Robert C. Duncan, Rebecca G. Knapp, and M. Clinton Miller III. John Wiley & Sons, 1977. vii + 163 pp. \$8.50 paper.

An elementary introduction to descriptive and inferential statistical techniques for health science professionals.

Elements of differential geometry. By Richard S. Millman, George D. Parker. Prentice-Hall, Inc., New Jersey, 1977. xiv + 265 pp. \$16.95.

An elementary and geometric introduction, studying the classical geometry of curves and surfaces by using modern vector space terminology. Global as well as local results are emphasized.

Multiple hypergeometric functions and applications. By Harold Exton. Halsted Press, London, 1976. 312 pp. \$27.50.

A volume in the series 'Mathematics and Applications'. It is the first book to assemble all the recent work on multiple hypergeometric functions. Their connection with ordinary hypergeometric function is explored, the differential equations which they satisfy are discussed, and various integral representations given. Numerous examples of their practical application are presented and the computing aspects covered, including typical Fortran programs.

Statistics for management decisions. By Donald R. Plane and Edward B. Oppermann. Business Publications, Inc., Texas, 1977. xv + 527 pp. \$14.95.

An elementary textbook designed for students of business or economics, assuming a good course in high school algebra as background.

Mathematics applied to continuum mechanics. By Lee A. Segel. Macmillan, New York, 1977. xviii + 590 pp. \$18.95.

This volume is a sequel to C. C. Lin and L. A. Segel's *Mathematics Applied to Deterministic Problems in the Natural Sciences*, and is written in the same spirit, viz. to demonstrate mathematical techniques at the hand of real-life examples. This case-study, heuristic approach is used consistently, at the expense of rigor, and brevity is sometimes sacrificed to permit depth of exposition. This volume is divided into four parts: geometrical prerequisites for three-dimensional continuum mechanics; problems in continuum mechanics; water waves; extremum principles.

Probability and statistical inference. By Robert V. Hogg and Elliot A. Tanis. Macmillan Publishing Co., New York, 1977. ix + 450 pp. \$14.95.

This book assumes no previous knowledge of statistics and only a year's calculus. It is, thus, a much more elementary version of the well-known "Hogg & Craig".

(continued on page 374)

(continued from page 356)

Probability methods for approximations in stochastic control and for elliptic equations. By Harold J. Kushner. Academic Press, New York, 1977. xv + 243 pp. \$23.00.

The book deals with a number of problems concerning approximations, convergence and numerical methods for stochastic control problems, and also for degenerate elliptic and parabolic equations.

The main mathematical techniques are those related to the use of results in the theory of weak convergence of a sequence of probability measures. The technique seems to provide a point of view that not only suggests numerical methods but also unites diverse problems in approximation theory and in stochastic control theory.

Microwave optics. By Sydney Cornbleet. Academic Press, London, New York, San Francisco, 1977. xvii + 416 pp. \$34.50.

The book is subtitled "The optics of microwave antenna design" and it treats the theory behind the design problems as well as applications.

Applications of linear algebra. By Chris Rorres and Howard Anton. John Wiley & Sons, New York, 1977. ix + 233 pp. \$4.95.

Applications to game theory, Markov chains, economic models, genetics, curve fitting, linear programming, forest management, etc., on the level of a sophomore course.

Mathematical modeling and digital simulation for engineers and scientists. By Jon M. Smith. John Wiley & Sons, New York, 1977. xii + 332 pp. \$21.00.

An elementary introduction to the simulation of complex continuous processes on digital computers.

Mathematical statistics: basic ideas and selected topics. By Peter J. Bickel and Kjell A. Doksum. Holden-Day, Inc., San Francisco, 1976. xiv + 493 pp. \$18.95.

This is a textbook for advanced undergraduates and graduate students in mathematics, statistics, the physical sciences and engineering. It provides modern, rigorous, in-depth coverage of statistical techniques for data-analysis, including their heuristic motivation and background. A brief introduction to probability is given and a good mathematics background (linear algebra and matrix theory, advanced calculus, but no measure theory) is assumed. There are many examples, some of considerable difficulty, but no solutions.

The book is distinguished by both depth of treatment and clarity of exposition, and conveys the authors' profound understanding of the subject. It will be a welcome text for statistics courses directed at mathematically inclined students.

The theory of partitions. By George E. Andrews. Addison-Wesley, Massachusetts, 1976. xvi + 255 pp. \$16.50.

This is volume 2 of the 'Encyclopedia of Mathematics and its Applications', and a volume in its section 'Number Theory'.

The theory of partitions has applications whenever discrete objects are counted or classified, such as in the molecular and the atomic studies of matter, in the theory of numbers, or in combinatorial problems from all sources. There are no prerequisite for its understanding. The book provides the first thorough survey of the field, with exhaustive references.

(continued on page 382)

(continued from page 374)

Multivariate statistical methods. 2nd ed. By D. F. Morrison. McGraw-Hill Book Co., New York, 1976. xv + 415 pp. \$15.95.

The first edition of this book was published in 1967. Chapter headings: 1. Some elementary statistical concepts; 2. Matrix algebra; 3. Samples from the multivariate normal population; 4. Tests of hypotheses on means; 5. The multivariate analysis of variance; 6. Classification by the linear discriminant function; 7. Inferences from covariance matrices; 8. Principal components; 9. Factor analysis.

Contributions to applied statistics. Ed. Walter J. Ziegler. Birkhäuser Verlag, Basel und Stuttgart, 1976. 202 pp. sFr. 118.-

This is a Festschrift dedicated to Professor Arthur Linden and consists of 27 papers by various authors grouped under the following headings: 1. General outlooks; 2. Sampling; 3. Estimation; 4. Testing; 5. Relationship; 6. Miscellaneous.

The general point process: applications to structural fatigue, bioscience, and medical research. By V. K. Murthy. Addison-Wesley Publishing Co., Massachusetts, 1974. xix + 604 pp. \$22.50; \$13.50 paperback.

This is volume 5 in the series Applied Mathematics and Computation. Chapter headings: 1. Preliminaries; 2. Estimation; 3. The cumulative point process; 4. The multidimensional point process; 5. Estimation of the variance of the counts resulting from a two-dimensional process; 6. Applications to cumulative fatigue damage of structures; 7. The superposition of arbitrary point processes; 8. Applications to life test data; 9. Interevent intervals for the point damage processes; 10. A two-parameter Weibull model for the interevent distribution; 11. and 12. Applications to biological and medical problems. A bibliography of 221 items.

Multiple scattering processes: inverse and direct. By Harriet H. Kagiwada, Robert Kalaba and Suetuo Ueno. Addison-Wesley Publishing Co., Reading, Mass., 1975. xvi + 336 pp. \$21.50; \$13.50 paperback.

This is volume 8 in the series 'Applied Mathematics and Computation'. Chapter headings: 1. Introduction: one-dimensional transport theory; 2. Isotropic scattering in slabs: auxiliary problem; 3. The basic problem: b and h functions; 4. Internal sources; 5. Inhomogeneous media; 6. Reflecting surfaces; 7. Anisotropic scattering.

The objectives of the book are: (i) to formulate inverse problems in radiative transfer and to show the effectiveness of quasilinearization in their computational resolution; (ii) to introduce the functions b and h and to indicate their fundamental role in the theory of multiple scattering; (iii) to derive initial value problems to replace boundary value problems and integral equations of multiple scattering, and to demonstrate their computational efficacy.

Mathematical programming via augmented Lagrangians. An introduction with computer programs. By Donald A. Pierre and Michael J. Lowe. Addison-Wesley Publishing Co., Reading, Mass., 1975. xxi + 436 pp. \$24.50; \$14.50 paperback.

This is volume 9 in the series 'Applied Mathematics and Computation' and its purposes are: (i) to treat a general nonlinear programming model theoretically while giving insight into the basic conditions of optimality upon which solution algorithms and methods of sensitivity can be based; (ii) to introduce a powerful method of nonlinear programming that employs augmented Lagrangians, leading to a comprehensive algorithm and computer program for solving NLP's that may depend on many variables and constraints; (iii) to provide test problems and application problems.

(continued on page 415)

(continued from page 382)

Computational probability and simulation. By Sidney J. Yakowitz. Addison-Wesley Publishing Co., Reading, Mass., 1977. xxii + 240 pp. \$22.50; \$12.50 paperback.

This is volume 12 in the series 'Applied Mathematics and Computation'. Chapter headings: 1. Random processes and random number generators; 2. Simulation of probability experiments; 3. Gaming, random walks, and linear equations; 4. Gambler's ruin with extensions to inventory control; 5. Limiting processes for random walks and time series simulation; 6. Monte Carlo integration and solution of differential equations. The programming language employed is Fortran.

Statistical theory. 3rd ed. By Barnard W. Lindgren. Macmillan Publishing Co., New York, 1976. xiii + 614 pp. \$14.95.

The most significant change in this new edition of a well-known text has been in the deferring of the decision-theoretic framework until after the special cases of estimation and testing have been studied.

Mathematical modelling. Edited by J. G. Andrews and R. R. McLone. Butterworth & Co., (Canada) Ltd. 1976. xvii + 260 pp. \$7.95.

A compendium of seventeen papers by various authors, illustrating applications of mathematics to real-life problems (viz., steering problems, rockets, liquid flow, molecular models, lasers, stress analysis, population models, diabetes, road traffic, business planning, control of grade structure in a university, automobile insurance, military applications of game theory, network flow, urban structure, catastrophe theory).

Queueing systems. Vol. I: Theory. By L. Kleinrock. John Wiley & Sons, New York, 1975. xviii + 417 pp. \$21.25.

Four parts: preliminaries (2 chapters), elementary queueing theory (2 chapters on birth-death and Markovian queues in equilibrium), intermediate queueing theory (3 chapters on the M/G/1 and G/M/m queues and the method of collective marks), advanced material (the queue G/G/1); appendices on transform and probability theory.

The exposition is at the first year graduate level and assumes a first course in probability theory.

Queueing systems. Vol. 2: computer applications. By L. Kleinrock. John Wiley & Sons. New York, 1976. xx + 549 pp. \$24.95.

Six chapters: 1. A queueing theory primer; 2. Bounds, inequalities and approximations; 3. Priority queueing; 4. Computer time-sharing and multiaccess systems; 5. Computer-communication networks; analysis and design; 6. Computer-communication networks; measurement, flow control and ARPANET traps.

The aims of this book are: (i) to modify the tools of queueing theory in a way that permits them to be applied to real-world problems; (ii) to make an extensive application of these tools to various and important modern-day computer systems.

Computational analysis with the HP-25 pocket calculator. By Peter Henrici. John Wiley & Sons, New York, 1977. xi + 280 pp. \$11.50.

The approximately 30 programs in this book implement algorithms in number theory, equation solving, algebraic stability theory, numerical integration and the evaluation of special functions such as the gamma function, various Bessel functions, and the Riemann zeta function. Flow diagrams and detailed descriptions are provided, making the programs easily adaptable to similar calculators. The purpose of the book is to teach students scientific computing and to serve as a handbook.

Model theory and algebra. a memorial tribute to Abraham Robinson. Ed. by D. H. Saracino and V. B. Weispfenning. Springer-Verlag, Berlin, Heidelberg, New York, 1975. x + 463 pp. \$15.20.

This is volume 498 of Lecture Notes in Mathematics and contains 16 papers, principally by former collaborators of Abraham Robinson, on model theory and algebra.

Inequalities in mechanics and physics. By G. Duvaut and J. L. Lions. Springer-Verlag, Berlin, Heidelberg, New York, 1976. xvi + 397 pp. \$40.20.

This is a translation from the French, by C. W. John, of the book published by Dunod in 1972. Chapter headings: 1. Problems of semi-permeable media and of temperature control; 2. Problems of heat control; 3. Classical problems and problems with friction in elasticity and visco-elasticity; 4. Unilateral phenomena in the theory of flat plates; 5. Introduction to plasticity; 6. Rigid visco-plastic Bingham fluid; 7. Maxwell's equations, antenna problems.

The problems in mechanics and physics discussed in this book can be expressed in terms of inequalities in situations where the constraints, the equations of state, the physical laws change when certain thresholds are crossed or attained.

Perturbation theory for linear operators. By T. Kato. Springer-Verlag, Berlin, Heidelberg, New York, 1976. 2nd ed. xvii + 619 pp. \$39.80.

The first edition was published in 1966. Here, supplementary notes and a supplementary bibliography are added to take account of recent developments.

Calculus with applications and computing, Vol. 1. By P. Lax, S. Burstein and A. Lax. Springer-Verlag, New York, Heidelberg, Berlin, 1976. xi + 513 pp.

Chapter headings: 1. Real numbers, 2. Functions, 3. Differentiation, 4. Integration, 5. Growth and decay, 6. Probability and its applications, 7. Rotation and the trigonometric functions, 8. Vibrations, 9. Population dynamics and chemical reactions. Appendix: Fortran programs and instructions for their use (finding zeros and maxima, Simpson's rule, evaluating $\log x$, $\exp x$, $\sin x$, $\cos x$).

The purpose of the book is to emphasize the relation of calculus to science, and the importance of finding numerical answers.

Rings of continuous functions. By Leonard Gillman and Meyer Jerison. Springer-Verlag, New York, Heidelberg, Berlin, 1976. xiii + 330 pp. \$14.80.

This is volume 43 of Graduate Texts in Mathematics and represents a second printing of the well-known work first published in 1960 by Van Nostrand.

Denumerable Markov chains. By J. G. Kemeny, J. L. Snell, and A. W. Knapp. Springer-Verlag, New York, Berlin, Heidelberg, 1976. xii + 477 pp. \$16.80.

This is volume 40 of Graduate Texts in Mathematics and is the second edition of the well-known work first published in 1966 by Van Nostrand. It contains a section indicating developments over the last ten years and additional references.

An invitation to C^ -algebra.* By William Arveson. Springer-Verlag, New York, Heidelberg, Berlin, 1976. x + 106 pp. \$12.80.

This is volume 39 of Graduate Texts in Mathematics and gives an introduction to C^* -algebras and their representations on Hilbert spaces. The most basic ideas only are presented, as simply and concretely as possible. The Bourbaki tradition has been systematically eschewed. It is appropriate for second year graduate students who are familiar with basic functional analysis, measure theory and Hilbert space.

Differential topology. By Morris W. Hirsch. Springer-Verlag, New York, Heidelberg, Berlin, 1976. x + 221 pp. \$14.80.

This is volume 33 of Graduate Texts in Mathematics and presents some of the basic topological ideas used in studying differentiable manifolds and maps. A standard course in analysis and general topology is adequate preparation. The geometrical and intuitive aspects are emphasized and there are hundreds of examples of varying difficulty.

Advanced mathematical analysis. By Richard Beals. Springer-Verlag, New York, Heidelberg, Berlin, 1973. x + 230 pp.

This is volume 12 in the series Graduate Texts in Mathematics, and is subtitled 'periodic functions and distributions, complex analysis, Laplace transform and applications'. It attempts a reconciliation between 'advanced mathematics for science and engineering' with 'advanced mathematical analysis for mathematicians'. Chapters 1 and 2 provide background; 3, 4, and 5 treat periodic functions and distributions, Fourier series, applications, including convolution and approximation (e.g., Weierstrass), characterization of period distributions, Hilbert spaces and the classical p.d.e.'s of mathematical physics; functions of a complex variable constitutes chapter 6; chapter 7 treats the Laplace transform from a distribution-theoretic point of view, with applications to o.d.e.'s.

Stable mappings and their singularities. By Martin Golubitsky and Victor Guillemin. Springer-Verlag, New York, Heidelberg, Berlin, 1973. x + 209 pp. \$9.50.

This is volume 14 of Graduate Texts in Mathematics and aims to present to first and second year graduate students the theory of singularities of stable differentiable mappings, which is based on the classical theories of Hassler Whitney.

Finite Markov chains. By J. G. Kemeny and J. Laurie Snell. Springer-Verlag, New York, Heidelberg, Berlin, 1976. ix + 210 pp. \$14.80.

A volume in the series Undergraduate Texts in Mathematics, this is a reprint of the well-known 1960 edition published by Van Nostrand.

Computer methods for mathematical computations. By G. E. Forsythe, M. A. Malcolm and C. B. Moler. Prentice-Hall Inc., New Jersey, 1977. xi + 259 pp. \$15.95.

This book contains FORTRAN subroutines for the solution of problems involving matrices, integrals, ordinary differential equations, spline functions, zeros and extrema of functions, least squares and Monte Carlo techniques. Exercises illustrate application of these subroutines to problems in physics, engineering, mathematics, ecology and statistics.

Mathematical models: mechanical vibrations, population dynamics and traffic flow. By Richard Haberman. Prentice-Hall, Inc. New Jersey, 1977. xiii + 402 pp. \$18.95.

The book is subtitled 'An introduction to applied mathematics', and the three areas are chosen to illustrate the methodology of the field. Calculus and some elementary ordinary differential equations are assumed as background.

Decisions with multiple objectives: preferences and value tradeoffs. By R. L. Keeney and H. Raiffa. John Wiley & Sons, New York, 1976. xviii + 569 pp. \$19.95.

A volume in the Wiley Series in Probability and Mathematical Statistics. Conceptually, the material in this book can be partitioned into four main categories: (1) the *structuring* of multiple-objective problems: Chapters 1 and 2; (2) the *theory* of quantifying preferences over multiple objectives: Chapters 3 through 6; (3) the *applications* of that theory: Chapters 7 and 8; (4) *special topics*: Chapters 9 and 10. The theory is illustrated by many concrete examples taken from a host of disciplinary settings.

Linear regression analysis. By G. A. F. Seber. John Wiley & Sons, New York, 1977. xvii + 465 pp. \$29.95.

A volume in the Wiley Series in Probability and Mathematical Statistics. A full discussion of the Assumptions underlying regression models is given and a variety of techniques for investigating these assumptions. Full rank and less than full rank models are dealt with at the same time by using a geometric approach, and the theory of generalized inverses is employed. In addition to the customary topics such as ANOVA and ANCOVA, unusual subjects are presented: optimal design, ridge estimators, two-phase regression, spline fractions, missing observations. Over 200 examples and outline solutions; a bibliography of about 600 references.

Algebraic topology—homotopy and homology. By Robert M. Switzer. Springer-Verlag, New York, Heidelberg, Berlin, 1975. xiii + 526 pp. \$52.50.

A systematic development of (unstable) homotopy theory, leading to an axiomatic treatment of homology and cohomology theories and their construction using spectra. Three main examples: ordinary homology theory, K-theory and bordism theories. The topologist's most useful tools are presented in the second half of the book, under the general framework of giving the functors of algebraic topology a sufficiently rich natural algebraic structure so that they can detect homotopically non-trivial maps.

Banach lattices and positive operators. By H. H. Schaefer. Springer-Verlag, New York, Heidelberg, Berlin, 1970. xi + 376 pp. \$40.20.

Chapter I: finite positive square matrices; Chapter II and a third of Chapter III: Banach lattices; rest of Chapter III and Chapters IV and V: operator theory. Main objective: to present the theory of Banach lattices and positive linear operators as an inseparable part of general Banach space and operator theory. 120 exercises. Extensive bibliography.

Econometrics. By G. S. Maddala. McGraw-Hill, New York, 1977. xii + 516 pp. \$18.50.

Introduction to probability and statistical inference (50 pp); introduction to econometric methods (200 pp); further discussion of selected topics (171 pp). Unusual topics: proxy variables, limited and dummy dependent variables, missing observations and aggregation problems; analysis of grouped data; pooling cross-section and time series data; aggregation over time; Hannan's estimator; distributed lag models; forecasting, varying parameter models. Attempts to present both economic theory and empirical applications.

Variational methods in theoretical mechanics. By J. T. Oden and J. N. Reddy. Springer-Verlag, Berlin, Heidelberg, New York, 1976. x + 302 pp. \$14.80.

A graduate textbook, assuming knowledge of functional analysis and continuum mechanics. Mathematical foundations of classical variational theory, mechanics of continua (a brief review), complementary and dual variational principles in mechanics, variational principles in continuum mechanics. Bibliography of 148 items.

Rings and categories of modules. By Frank W. Anderson and Kent R. Fuller. Springer-Verlag, New York, Heidelberg, Berlin, 1974. viii + 339 pp. \$19.80.

Graduate Texts in Mathematics, volume 13. Theme of the text: study of the relationship between the one-sided ideal structure that a ring may possess and the behavior of its categories of modules. Set-theoretic and categorical foundations, basic definitions and properties of rings, modulus and homomorphisms, direct sums, finiteness conditions, the Wedderburn-Artin Theorem, the Jacobson radical, the hom and tensor functions, Morita equivalence and duality, decomposition theory of injective and projective modules, semiperfect and perfect rings. Many exercises.

Mathematical logic. By J. Donald Monk. Springer-Verlag, New York, Heidelberg, Berlin, 1976. x + 531 pp. \$19.80.

Graduate Texts in Mathematics, volume 37. A development of lectures given by the author at the University of Colorado and the University of California, Berkeley. Part I: recursive function theory; Part II: elementary logic; Part III: treats the question: given a theory T, is there an automatic method for determining the validity of sentences in T. Gödel's results; Part IV: what is the relationship between semantic properties of languages and their formal characteristics? Russell-Whitehead's theory of types, etc.

APL: the language and its usage. By Raymond P. Polivka and Sandra Pakin. Prentice-Hall, Inc., New Jersey, 1975. xxiii + 579 pp. \$19.95.

A complete and comprehensive presentation of APL based on APL.SV, with more than 180 example programs from many fields of application, and over 400 problems.

Abstract algebra, a first look. By Joseph E. Kuczkowski and Judith L. Gersting. Marcel Dekker, New York, 1977. viii + 323 pp. \$17.50.

This is volume 38 in the series 'Pure and Applied Mathematics'. Designed for an introductory, one semester course, it uses the underlying concepts of structures, substructures, morphisms and quotient structures to cycle through the various algebraic structures (groups, rings, fields, vector spaces) several times, with greater detail at each encounter. There are practice problems in the body of the text, with answers at the bottom of the page.

Lecture Notes in Economics and Mathematical Systems 139: Production theory and its applications. Edited by H. Albach and G. Uergendahl. Springer-Verlag, Berlin, Heidelberg, New York, 1977. xiii + 186 pp. \$8.00.

These are the proceedings of a workshop organized by the European Institute for Advanced Studies in Management, in Brussels, November 1974. It is divided into (a) industrial production problems, (b) production problems in Universities.

Lecture Notes in Economics and Mathematical Systems 142: On optimal population paths.
By John S. Lane. Springer-Verlag, Berlin, Heidelberg, New York, 1977. v + 123 pp.
\$8.00.

The purpose of this monograph is to integrate and critically evaluate the existing literature in the area of optimal joint savings population programs.

Lecture Notes in Economics and Mathematical Systems 194: An analysis of economic size distributions. By Bertil Näslund. Springer-Verlag, Berlin, Heidelberg, New York, 1977.
xv + 100 pp. \$8.00.

The author studies (a) income distributions, (b) functional distributions of income, (c) size distributions of firms and makes some tests of the distributions found against data for different countries.

Proceedings of the International Symposium on Modern Developments in Fluid Dynamics.
Edited by J. Rom. Soc. for Industrial and Applied Mathematics, Philadelphia, 1977.
xxiii + 393 pp.

These are the proceedings of a symposium, held at Haifa, Israel, December 16–23, 1973 (two months after the Yom Kippur war!), in honor of the 70th birthday of Sydney Goldstein. The proceedings are introduced by an article 'Goldstein and Fluid Dynamics' by Sir James Lighthill, who divides his discussion of Goldstein's contributions into the following parts: 1. Fluid mathematics, 2. Boundary layers and wakes, 3. Instability and turbulence, 4. Aerodynamics. The following papers are included: Fluid Dynamics of Liquid Helium (H. W. Liepman); Kinematic Dynamos and the Earth's Magnetic Field (C. L. Pekeris, Y. Accad and B. Shkoller); On Spiral Waves in Galaxies—A Gas Dynamic Approach (C. C. Lin and Y. Y. Lau); The Knudsen Boundary Layer in Low Density Gas Flow Past a Crystal (Leon Trilling); The Effect of Strain Rate on Diffusion Flames (G. F. Carrier, F. W. Fendell and F. E. Marble); Vortex Wakes of Bluff Cylinders in Shear Flow (W. A. Mair and P. K. Stansby); Difference Schemes with Fourth Order Accuracy for Hyperbolic Equations (S. Abarbanel, D. Gottlieb, and E. Turkel); Computer Extension of Perturbation Series in Fluid Mechanics (Milton Van Dyke); Modern Developments in Transonic Flow (Julian D. Cole); Wave Breakdown and Turbulence (Marten T. Landahl); Disturbances in a Boundary Layer Introduced by a Low Intensity Array of Vortices (H. L. Rogler and Eli Reshotko); Some Remarks on Shock Wave Turbulent Boundary-Layer Interaction at High Reynolds Number (S. M. Bogdonoff); Flows with Strong Interaction Between Viscous and Inviscid Regions (J. Rom); On the Asymptotic Theory of Separated and Unseparated Fluid Motions (K. Stewartson); Boundary Layer Separation in Unsteady Flow (W. R. Sears and D. P. Telionis); On the Highest and Other Solitary Waves (James Witting); Solutions of the Navier-Stokes Equation at Large Reynolds Number (P. A. Lagerstrom); On the Weis-Fogh Mechanism of Lift Generation (Sir James Lighthill)

The Proceedings conclude with a brief report by Nina Geffen on the Round Table Discussion at the Symposium.