

QUARTERLY
OF
APPLIED MATHEMATICS

EDITED BY

H. T. BANKS
G. F. CARRIER
H. COHEN
J. D. COWAN
C. DAFERMOS
Assoc. Managing Editor
P. J. DAVIS

D. C. DRUCKER
H. W. EMMONS
C. FERRARI
P. GERMAIN
U. GRENANDER
G. E. HAY
P. LE CORBEILLER
E. REISSNER

J. R. RICE
S. A. SCHELKUNOFF
W. R. SEARS
L. SIROVICH
J. J. STOKER
P. S. SYMONDS
J. L. SYNGE

W. F. FREIBERGER *Managing Editor*

FOUNDER, AND
MANAGING EDITOR 1943–1965
W. PRAGER

VOLUME LI

DECEMBER • 1993

NUMBER 4


QUARTERLY OF APPLIED MATHEMATICS

The QUARTERLY prints original papers in applied mathematics which have an intimate connection with applications. It is expected that each paper will be of a high scientific standard; that the presentation will be of such character that the paper can be easily read by those to whom it would be of interest; and that the mathematical argument, judged by the standard of the field of application, will be of an advanced character.

Manuscripts (two copies) submitted for publication in the QUARTERLY OF APPLIED MATHEMATICS should be sent to the Editorial Office, Box F, Brown University, Providence, RI 02912, either directly or through any one of the Editors. The final decision on acceptance of a manuscript for publication is made by the Managing Editor. In accordance with their general policy, the Editors welcome particularly contributions which will be of interest both to mathematicians and to scientists or engineers. Authors will receive galley proof only. The author's institution will be requested to pay a publication charge of \$30 per page which, if honored, entitles the author to 100 free reprints. Detailed instructions will be sent with galley proofs.

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

© 1993 Brown University

 Printed on recycled paper

Second-class postage paid at Providence, Rhode Island.

Publication number 808680 (ISSN 0033-569X).

QUARTERLY
OF
APPLIED MATHEMATICS

EDITED BY

H. T. BANKS
G. F. CARRIER
H. COHEN
J. D. COWAN
C. DAFERMOS
Assoc. Managing Editor
P. J. DAVIS

D. C. DRUCKER
H. W. EMMONS
C. FERRARI
P. GERMAIN
U. GRENANDER
G. E. HAY
P. LE CORBEILLER
E. REISSNER

J. R. RICE
S. A. SCHELKUNOFF
W. R. SEARS
L. SIROVICH
J. J. STOKER
P. S. SYMONDS
J. L. SYNGE

W. F. FREIBERGER *Managing Editor*

FOUNDER, AND
MANAGING EDITOR 1943–1965
W. PRAGER

ANNUAL INDEX

GREGOIRE ALLAIRE AND ROBERT V. KOHN: Explicit optimal bounds on the elastic energy of a two-phase composite in two space dimensions	675
GREGOIRE ALLAIRE AND ROBERT V. KOHN: Optimal bounds on the effective behavior of a mixture of two well-ordered elastic materials	643
J. BADUR (<i>see</i> STUMPF, H.)	
B. S. BERGER, M. ROKNI, AND I. MINIS: Complex dynamics in metal cutting	601
P. BISEGNA (<i>see</i> ROMANO, G.)	
C. M. BRAUNER, P. C. FIFE, G. NAMAH, AND C. SCHMIDT-LAINÉ: Propagation of a combustion front in a striated solid medium: An homogenization analysis.....	467
DENNIS W. BREWER, JOHN A. BURNS, AND EUGENE M. CLIFF: Parameter identification for an abstract Cauchy problem by quasilinearization	1
M. A. BRUTYAN AND P. L. KRPIVSKY: Collapse of spherical bubbles in fluids with nonlinear viscosity	745
JOHN A. BURNS (<i>see</i> BREWER, DENNIS W.)	
CONSTANTINE J. CALLIAS AND XANTHIPPI MARKENSCOFF: The singularity of the stress field of two nearby holes in a planar elastic medium	547
B. CASSIS, O. TIKHOMIROV, AND B. A. WAGNER: Asymptotic solution for nonlinear chemical vapor deposition problems	585
XINFU CHEN AND AVNER FRIEDMAN: The thermistor problem for conductivity which vanishes at large temperature	101
EUGENE M. CLIFF (<i>see</i> BREWER, DENNIS W.)	
K. L. COOKE, J. TURI, AND G. TURNER: Spectral conditions and an explicit expression for the stabilization of hybrid systems in the presence of feedback delays	147
W. A. DAY: Entropy and elliptic equations	191
R. W. DICKEY AND J. J. ROSEMAN: Equilibria of the circular elastica under a uniform central force field	201
JOSEPH D. FEHRIBACH: Analysis and application of a continuation method for a self-similar coupled Stefan system	405
P. C. FIFE (<i>see</i> BRAUNER, C. M.)	
STATHIS FILIPPAS AND JONG-SHENQ GUO: Quenching profiles for one-dimensional semilinear heat equations	713
ROGER FOSDICK AND ERIC VOLKMANN: Normality and convexity of the yield surface in nonlinear plasticity	117
AVNER FRIEDMAN (<i>see</i> CHEN, XINFU)	
METIN GÜRGÖZE (<i>see</i> GROSS, PETER)	
G. GENTILI (<i>see</i> GIORGI, C.)	
ROBERTO GIANNI AND PAOLA MANNUCCI: Existence theorems for a free boundary problem in combustion theory	43
C. GIORGI AND G. GENTILI: Thermodynamic properties and stability for the heat flux equation with linear memory	343
GUSTAF GRIPENBERG: Unimodality and viscoelastic pulse propagation	183
PETER GROSS, METIN GÜRGÖZE, AND WOLFHARD KLIEM: Bifurcation and stability analysis of a rotating beam	701
JONG-SHENQ GUO (<i>see</i> FILIPPAS, STATHIS)	
W. W. HACKBORN: On a class of Stokes flows inside a corrugated boundary	329
DESMOND L. HILL AND JAMES M. HILL: Superimposed travelling wave solutions for nonlinear diffusion	633

JAMES M. HILL (<i>see</i> HILL, DESMOND L.)	
Y. E. HOHLOV AND S. D. HOWISON: On the classification of solutions to the zero-surface-tension model for Hele-Shaw free boundary flows	777
SELWYN L. HOLLIS: On the question of global existence for reaction-diffusion systems with mixed boundary conditions	241
C. O. HORGAN AND L. E. PAYNE: The effect of constitutive law perturbations on finite antiplane shear deformations of a semi-infinite strip	441
S. D. HOWISON (<i>see</i> HOHLOV, Y. E.)	
BEI HU AND HONG-MING YIN: Determination of the leading coefficient $a(x)$ in the heat equation $u_t = a(x)\Delta u$	577
WANG HUAIZHONG (<i>see</i> YONG, LI)	
K. HUSEYIN (<i>see</i> YU, P.)	
SONG JIANG: Global large solutions to initial boundary value problems in one-dimensional nonlinear thermoviscoelasticity	731
M. C. JORGE AND A. A. MINZONI: Examples of bifurcation from a continuum of eigenvalues and from the continuous spectrum	37
WOLFHARD KLIEM (<i>see</i> GROSS, PETER)	
ROBERT V. KOHN (<i>see</i> ALLAIRE, GREGOIRE)	
W. KOSIŃSKI AND K. SAXTON: The effect on finite time breakdown due to modified Fourier laws	55
P. L. KRAPIVSKY (<i>see</i> BRUTYAN, M. A.)	
P. SAM LAWRENCE AND B. NAGESWARA RAO: Reinvestigation of the nonuniqueness of the flow of a viscoelastic fluid over a stretching sheet	401
CHJAN C. LIM AND LAWRENCE SIROVICH: Nonlinear vortex trail dynamics Part II: Analytic solutions	129
XINZHI LIU: On attractivity for nonautonomous systems	319
ZHUANGYI LIU AND SONGMU ZHENG: Exponential stability of the semigroup associated with the thermoelastic system	535
G. LOHÖFER: Force and torque of an electromagnetically levitated metal sphere	495
MASSIMILIANO LUCCHESI: Free-energy functions for elastic-plastic material elements ...	299
S. K. MALIK AND M. SINGH: Nonlinear field instability and chaos in magnetic fluids ...	519
PAOLA MANNUCCI (<i>see</i> GIANNI, ROBERTO)	
XANTHIPPI MARKENSCOFF (<i>see</i> CALLIAS, CONSTANTINE J.)	
F. MAROTTI DE SCIARRA (<i>see</i> ROMANO, G.)	
AKIRA MASUDA: The completeness theorem for Rossby normal modes of a stably stratified flat ocean with an arbitrary form of side boundary	425
B. J. MATKOWSKY AND V. VOLPERT: Stability of plane wave solutions of complex Ginzburg-Landau equations	265
M. F. MCCARTHY, T. B. MOODIE, T. S. ÖNCÜ, AND R. P. SAWATZKY: Propagation and reflection of one-dimensional waves in ferroelectric ceramics	217
I. MINIS (<i>see</i> BERGER, B. S.)	
A. A. MINZONI (<i>see</i> JORGE, M. C.)	
T. B. MOODIE (<i>see</i> MCCARTHY, M. F.)	
G. NAMAH (<i>see</i> BRAUNER, C. M.)	
JOHANNES C. C. NITSCHKE: Boundary value problems for variational integrals involving surface curvatures	363
T. S. ÖNCÜ (<i>see</i> MCCARTHY, M. F.)	
L. E. PAYNE AND P. W. SCHAEFER: Some nonstandard problems for the Poisson equation	81
L. E. PAYNE (<i>see</i> HORGAN, C. O.)	
NANCY M. PFENNING AND W. O. WILLIAMS: On nonmaterial surfaces with structure ..	559

R. RACKE, Y. SHIBATA, AND S. ZHENG: Global solvability and exponential stability in one-dimensional nonlinear thermoelasticity	751
B. NAGESWARA RAO (<i>see</i> LAWRENCE, P. SAM)	
M. ROKNI (<i>see</i> BERGER, B. S.)	
G. ROMANO, L. ROSATI, F. MAROTTI DE SCIARRA, AND P. BISEGNA: A potential theory for monotone multivalued operators	613
L. ROSATI (<i>see</i> ROMANO, G.)	
J. J. ROSEMAN (<i>see</i> DICKEY, R. W.)	
R. P. SAWATZKY (<i>see</i> MCCARTHY, M. F.)	
K. SAXTON (<i>see</i> KOSIŃSKI, W.)	
P. W. SCHAEFER (<i>see</i> PAYNE, L. E.)	
C. SCHMIDT-LAINÉ (<i>see</i> BRAUNER, C. M.)	
JINGYU SHI: Plane deformations of membranes and networks with circular cords.....	69
Y. SHIBATA (<i>see</i> RACKE, R.)	
M. SINGH (<i>see</i> MALIK, S. K.)	
LAWRENCE SIROVICH (<i>see</i> LIM, CHJAN C.)	
C. A. STUART: Estimating the critical radius for radially symmetric cavitation	251
H. STUMPF AND J. BADUR: On objective surface rates	161
DECHUN TAN: Riemann problem for hyperbolic systems of conservation laws with no classical wave solutions	765
O. TIKHOMIROV (<i>see</i> CASSIS, B.)	
T. C. T. TING (<i>see</i> WANG, M. Z.)	
TON TRAN-CONG: On Helmholtz's decomposition theorem and Poisson's equation with an infinite domain.....	23
J. TURI (<i>see</i> COOKE, K. L.)	
G. TURNER (<i>see</i> COOKE, K. L.)	
LAWRENCE TURYN: The damped Mathieu equation	389
ERIC VOLKMANN (<i>see</i> FOSDICK, ROGER)	
V. VOLPERT (<i>see</i> MATKOWSKY, B. J.)	
B. A. WAGNER (<i>see</i> CASSIS, B.)	
M. Z. WANG, T. C. T. TING, AND GONGPU YAN: The anisotropic elastic semi-infinite strip	283
W. O. WILLIAMS (<i>see</i> PFENNING, NANCY M.)	
LÜ XIANRUI (<i>see</i> YONG, LI)	
GONGPU YAN (<i>see</i> WANG, M. Z.)	
HONG-MING YIN (<i>see</i> HU, BEI)	
LI YONG, WANG HUAIZHONG, AND LÜ XIANRUI: Equilibrium of permanent multivalued systems.....	791
P. YU AND K. HUSEYIN: On phase-locked motions associated with strong resonance ...	91
S. ZHENG (<i>see</i> RACKE, R.)	
SONGMU ZHENG (<i>see</i> LIU, ZHUANGYI)	

SUGGESTIONS CONCERNING THE PREPARATION OF MANUSCRIPTS FOR THE QUARTERLY OF APPLIED MATHEMATICS

The editors will appreciate the authors' cooperation in taking note of the following directions for the preparation of manuscripts. These directions have been drawn up with a view toward eliminating unnecessary correspondence, avoiding the return of papers for changes, and reducing the charges made for "author's corrections."

Manuscripts: Manuscripts should be typewritten double-spaced on one side only. Marginal instructions to the typesetter should be written in pencil to distinguish them clearly from the body of the text. The author should keep a complete copy.

The papers should be submitted in final form. Only typographical errors should be corrected in proof; composition charges for any major deviations from the manuscript will be passed on to the author.

Titles: The title should be brief but express adequately the subject of the paper. The name and initials of the author should be written as he/she prefers; all titles and degrees or honors will be omitted. The name of the organization with which the author is associated should be given in a separate line following his/her name.

Mathematical Work: As far as possible, formulas should be typewritten; Greek letters and other symbols not available on the average typewriter should be inserted using either instant lettering or by careful insertion in ink. Manuscripts containing pencilled material other than marginal instructions to the typesetter will not be accepted.

The difference between capital and lower-case letters should be clearly shown; care should be taken to avoid confusion between zero (0) and the letter *O*, between the numeral one (1), the letter *l* and the prime ('), between alpha and *a*, kappa and *k*, mu and *u*, nu and *v*, eta and *n*.

The level of subscripts, exponents, subscripts to subscripts, and exponents to exponents should be clearly indicated.

Single embellishments over individual letters are allowed; the only embellishment allowed above groups of letters is the overbar.

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

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

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

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

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.

CONTENTS

Vol. LI, No. 4

December 1993

B. S. BERGER, M. ROKNI, AND I. MINIS : Complex dynamics in metal cutting	601
G. ROMANO, L. ROSATI, F. MAROTTI DE SCIARRA, AND P. BISEGNA: A potential theory for monotone multivalued operators	613
DESMOND L. HILL AND JAMES M. HILL: Superimposed travelling wave solutions for nonlinear diffusion	633
GREGOIRE ALLAIRE AND ROBERT V. KOHN: Optimal bounds on the effective behavior of a mixture of two well-ordered elastic materials	643
GREGOIRE ALLAIRE AND ROBERT V. KOHN: Explicit optimal bounds on the elastic energy of a two-phase composite in two space dimensions	675
PETER GROSS, METIN GÜRGÖZE, AND WOLFHARD KLIEM: Bifurcation and stability analysis of a rotating beam	701
STATHIS FILIPPAS AND JONG-SHENQ GUO: Quenching profiles for one-dimensional semilinear heat equations	713
SONG JIANG : Global large solutions to initial boundary value problems in one-dimensional nonlinear thermoviscoelasticity	731
M. A. BRUTYAN AND P. L. KRAPIVSKY: Collapse of spherical bubbles in fluids with nonlinear viscosity	745
R. RACKE, Y. SHIBATA, AND S. ZHENG: Global solvability and exponential stability in one-dimensional nonlinear thermoelasticity	751
DECHUN TAN: Riemann problem for hyperbolic systems of conservation laws with no classical wave solutions	765
Y. E. HOHLOV AND S. D. HOWISON: On the classification of solutions to the zero-surface-tension model for Hele-Shaw free boundary flows	777
LI YONG, WANG HUAIZHONG, AND LÜ XIANRUI: Equilibrium of permanent multivalued systems	791
NEW BOOKS	632, 642, 700, 712, 730, 750, 764, 790, 796

Applied Linear Statistical Models: Regression, Analysis of Variance, and Experimental Designs, Third Edition. By John Neter, William Wasserman, and Michael H. Kutner. Richard D. Irwin, Inc., 1990. xvi + 1181 pages. \$51.95.

The third edition of this popular text differs from the second in a number of respects. A new chapter (#28) on repeated measures designs has been added. Chapter 12 on regression model building has been largely recast and greatly expanded, as has the treatment of the validation of regression models. The discussion of regression and analysis of variance diagnostics has been greatly expanded throughout the text. A number of other topics have been reorganized and expanded: the discussion of weighted least squares is unified and taken up in conjunction with multiple regression; that of standardized regression models has been reorganized, as have been the developments of extra sums of squares and multicollinearity; Chapter 13 on autocorrelation has been expanded, and a discussion of response-surface methodology included in Chapter 9 on polynomial regression. The explanation of ANOVA models has been expanded, especially for random and mixed effects models for randomized block designs, nested designs, repeated measures designs, and latin square designs. In particular, the correspondence between an ANOVA model and the correlation structure of the observations has been emphasized. The integration of experimental designs and observational studies has been strengthened throughout the book, beginning with the discussion of obtaining data for regression analysis in Chapter 2. Throughout the text, the authors have made extensive revisions in the exposition to improve its clarity, on the basis of classroom experience. The authors claim that a key feature of the text is its unified approach to regression, ANOVA and experimental designs. The notion of a general linear statistical model, which arises naturally in the context of regression models, is carried over to ANOVA and experimental design models to bring out their relation to regression models.

Matrix Perturbation Theory. By G. W. Stewart and Ji-guang Sun. Academic Press, 1990. xv + 365 pages. \$49.95.

The book is largely concerned with perturbation bounds—giving bounds on the error (or perturbation) in the function in terms of a bound on the error in the argument—rather than perturbation expansions, the approximation of the error in the function in terms of the error in the argument, although it does give some of the latter. The problems chosen are apparent from the chapter titles: 1. Preliminaries; 2. Norms and metrics; 3. Linear systems and least squares problems; 4. The perturbation of eigenvalues; 5. Invariant subspaces; 6. Generalized eigenvalue problems.

Introduction to Algorithms. By Thomas H. Cormen, Charles E. Leiserson, and Ronald L. Rivest. The MIT Press, 1990. xvii + 1028 pages. \$49.95.

This is a volume in The MIT Electrical Engineering and Computer Science Series. It provides a comprehensive introduction to the modern study of computer algorithms, presenting many of them and covering them in considerable depth, yet making their design and analysis accessible to all levels of readers. Each chapter presents an algorithm, a design technique, an application area, or a related topic. Algorithms are described in English and in a pseudocode designed to be readable by anyone who has done a little programming. The book contains over 260 figures illustrating how the algorithms work. The authors emphasize efficiency as a design criterion and include careful analyses of the running times of all their algorithms. They discuss engineering issues in algorithm design, as well as mathematical aspects. The text is intended primarily for use in undergraduate or graduate courses in algorithms or data structures, but is equally well suited for self-study. The bibliography contains 205 items. There are 37 chapters, grouped into seven parts, entitled: 1. Mathematical foundations; 2. Sorting and order statistics; 3. Data structures; 4. Advanced design and analysis techniques; 5. Advanced data structures; 6. Graph algorithms; 7. Selected topics.

Continued from page 632

Discrete Location Theory. Edited by Pitu B. Mirchandani and Richard L. Francis. John Wiley and Sons, 1990. xiv + 555 pages. \$64.95.

This is a volume in the Wiley-Interscience Series in Discrete Mathematics and Optimization. Its twelve chapters, written by authorities in the respective fields, review the state-of-the-art of the theory and applications of discrete location theory and algorithms. They examine the ingredients of locational analysis, the p -median problem and generalizations, the uncapacitated facility location problem, and the multi-period capacitated location models. They cover decomposition methods for facility location problems, covering problems, p -center problems, and relevant duality. Also, the quadratic assignment problem is discussed in detail, as are strategies for finding locations of competing facilities and the equilibrium analysis for the resulting competitive location problems. The final chapter discusses problems of locating mobile units in a stochastic environment.

Semiconductor Equations. By P. A. Markowich, C. A. Ringhofer, and C. Schmeiser. Springer-Verlag, 1990. x + 248 pages. \$54.50.

The focus of this book is the presentation of the hierarchy of semiconductor models ranging from kinetic transport equations to the drift diffusion equations. Particular emphasis is given to the derivation of the models and the physical and mathematical assumptions used in the derivation. The authors do not enter into the mathematical technicalities necessary for a detailed analysis of the models but rather sacrifice rigor for the sake of conveying the basic properties and features of the model equations. The book is addressed to applied mathematicians, electrical engineers, and solid state physicists, the exposition being accessible to graduate students in these fields. Chapter headings: 1. Kinetic transport models for semiconductors; 2. From kinetic to fluid dynamical models; 3. The drift diffusion equations; 4. Devices.

Geometry—A Comprehensive Course. By Dan Pedoe. Dover Publications, 1988. xiv + 447 pages. \$11.95.

This is an unabridged and corrected republication of the work first published by the Cambridge University Press in 1970 under the title *A Course of Geometry for Colleges and Universities*. The scope of the book—designed to “increase geometrical, and therefore mathematical, understanding, and to help students to enjoy geometry”—is apparent from the table of contents: 0. Preliminary notions; 1. Vectors; 2. Circles; 3. Coaxial systems of circles; 4. The representation of circles by points in space of three dimensions; 5. Mappings of the Euclidean plane; 6. Mappings of the inversive plane; 7. The projective plane and projective space; 8. The projective geometry of n dimensions; 9. The projective generation of conics and quadrics; 10. Prelude to algebraic geometry.

The Theory of Probability. By B. Gnedenko. Mir Publishers, Moscow, distributed by Imported Publications, Chicago, 1989. 392 pages. \$12.95.

This is a translation from the Russian, by George Yankovsky, of the well-known treatise first published in English in 1969. It is the sixth printing. There are eleven chapters, the material progressing from the elements of the subject to the classical limit theorems, infinitely divisible laws, the theory of the stochastic processes, and the elements of queueing theory.

Continued on page 700

Continued from page 642

Artificial Intelligence at MIT: Expanding Frontiers. Edited by Patrick Henry Winston with Sarah Alexandra Shellard. The MIT Press, 1990, Volume 1: xvii + 656 pages. Volume 2: xv + 634 pages. \$45.00 (each volume), \$80.00 (the set).

This two-volume set of forty-three contributions presents the latest state-of-the-art research emerging from the Artificial Intelligence Laboratory at MIT. The papers are divided into six groups, entitled, respectively: 1. Scalable solutions for real-world problems; 2. Fueling the next generation; 3. Creating hardware and software revolutions; 4. Conquering unstructured environments; 5. Jumping through hoops and manipulating others; 6. Recognizing objects and understanding images. Individually, the contributions describe work that ranges from immediately applicable, demonstrated advances to theoretical proposals in areas like intelligent scientific computing, mechanical invention and design, database mining, qualitative decision making, computer-aided programming, natural language understanding, robot problem solving, robot manipulation and locomotion, visual recognition, image understanding, knowledge representation, network computation and learning, computer hardware and software innovation, and basic theory. Collectively the contributions show how researchers in Artificial Intelligence are developing scalable solutions to real problems, coping with unmodelable and chaotic worlds, exploiting mechanisms for learning and regularity recognition, and benefiting from massive parallelism. Each chapter is introduced by a short vignette, providing historical perspective, explaining the key ideas, describing exciting results, and suggesting practical consequences.

Advances in the Spatial Theory of Voting. Edited by James M. Enelow and Melvin J. Hinich. Cambridge University Press, 1990. xi + 240 pages. \$42.50.

A foreword by Kenneth Arrow puts the eight original essays in this volume into their historical perspective. The spatial theory of voting assumes that actors are motivated by self-interest and explores the consequences of this assumption for elite behaviour and for the choices voters make in representative and direct democracies. The book summarizes work in eight major areas: elections with possible entry by new candidates, strategic maneuvers designed to alter voting outcomes, elections with candidates who have policy preferences, experimental testing of spatial models of committees and elections, elections with imperfect information about voting intentions, voting on alternatives that are linked to future decisions, elections with more than two candidates under different election rules, and bureaucratic efforts to manipulate referendum voting.

A World Ruled by Number—William Stanley Jevons and the Rise of Mathematical Economics. By Margaret Schabas. Princeton University Press, 1990. xii + 192 pages. \$29.95.

In this monograph, the author demonstrates that the advent of mathematical economics in late Victorian England resulted more from new currents in logic and the philosophy of science than from problems specific to the classical theory of value and distribution. She shows that Jevons' *Principles of Science* (1874) was the first book to take issue with John Stuart Mill's faith in inductive reasoning, to assimilate George Boole's mathematical logic, and to discern many of the limitations that beset scientific inquiry, and she demonstrates that together with a renewed appreciation of Bentham's utility calculus, these philosophical insights served to convince Jevons and his followers that the economic world is fundamentally quantitative and thus amenable to mathematical analysis. There are eight chapters: 1. Mathematical pursuits; 2. Jevon's life; 3. The mathematical theory of economics; 4. Logic and scientific method; 5. Markets and mechanics; 6. Response to the *Theory*; 7. Mathematical economics takes hold; 8. Mathematical hegemony.

Continued on page 712

Continued from page 700

The Plateau Problem. By A. T. Fomenko. Gordon and Breach Science Publishers, 1990; Part 1: Historical Survey, xii + 220 pages. \$175.00; Part 2: The Present State of the Theory. xii + 251 pages, \$175.00; the two part set: \$245.00.

This is Volume 1 in the series Studies in the Development of Modern Mathematics. A Series of Books and Monographs on the development of mathematical concepts within their scientific and historical context, edited by Yu. I. Manin of the Steklov Institute of Mathematics, Moscow. The author, a member of the Faculty of Mechanics and Mathematics of the Moscow State University, has set himself the goal of writing a comparatively small book, relative to the wealth of literature available on the Plateau problem, in accordance with the following principle: maximum of clarity and minimum of formalization. The first volume contains three chapters: 1. Historical survey and introduction to the theory of minimal surfaces; this gives a survey of the origin of the Plateau problem; 2. Survey of some important publications in minimal surface theory from the nineteenth to the early twentieth century; this contains fragments of papers by Monge, Poisson, Plateau, Douglas, and Radó; 3. Some facts from elementary topology; this chapter is of an auxiliary character, containing information regarding homology and cohomology theories, necessary for modern multidimensional problems. The second volume contains the fourth chapter, entitled Modern State of Minimal Surface Theory, in which the author considers mostly the results obtained since the sixties, but first lists some important earlier results relating to the two-dimensional Plateau problem.

Integrals and Series. Volume 3: More Special Functions. By A. P. Prudnikov, Yu. A. Brychkov, and O. I. Marichev. Translated from the Russian by G. G. Gould. Gordon and Breach Science Publishers, 1990. 800 pages. \$175.00.

This handbook contains tables of indefinite and definite integrals, finite sums and series, and the functions of Struve, Weber, Anger, Lommel, Kelvin, Airy, Legendre, Whittaker, the hypergeometric and elliptic function, the Mathieu functions, the MacRobert function, the Meijer function, the Fox function, and several others. The book also contains tables of representations of generalized hypergeometric functions, and tables of Mellin transforms of a wide class of elementary and special functions, combined with tables of special cases of the Meijer G -function. The main text is preceded by a detailed list of contents from which the required formulae can be found. This handbook brings up to date the Bateman Manuscript Project volumes by A. Erdélyi and the handbook by I. S. Gradshteyn and I. M. Ryzhik, books that contained formulae known up to the end of the '40s only. This handbook reflects new results developed since then, and represents a more complete reference manual.

Practical Time-Stepping Schemes. By W. L. Wood. Oxford University Press, 1990. ix + 373 pages. \$37.50.

The aim of this book, a volume in the Oxford Applied Mathematics and Computing Science Series, is to give the mathematical background necessary for the understanding of the most popular algorithms which have been proposed for the solution of time-dependent problems. The book includes a study of the equations for modelling aquifers, heat conduction and diffusion, the dynamic vibration of structures, and associated non-linear and coupled problems where space discretization is done by the finite element method. The results are first- and second-order differential equations of a particular form. Chapter headings: 1. The differential equations; 2. p -step and p -stage schemes; 3. Newmark and the θ -method; 4. General theory and higher-order p -step and p -stage methods; 5. Other single step methods. Global crunch or divide and conquer?; 6. The energy method; 7. Non-linear equations; 8. Coupled systems.

Continued on page 730

Continued from page 712

Asymptotics in Statistics: Some Basic Concepts. By Lucien Le Cam and Grace Lo Yang. Springer-Verlag, 1990. viii + 180 pages. \$29.00.

These are translated and updated lecture notes first published in French by the Presses of the University of Montreal in 1968. The authors have deleted obsolete material and sketched some of the results acquired during the past twenty years. They have attempted to present a few concepts and tools in an elementary manner, referring the reader to the general literature for further information. Chapter headings: 1. Introduction; 2. Experiments, deficiencies, distances; 3. Contiguity—Hellinger transforms; 4. Limit laws for likelihood ratios obtained from independent observations; 5. Locally asymptotically normal families; 6. Independent, identically distributed observations; 7. On Bayes procedures.

Boundary Value Problems for Elliptic Equations and Systems. By Guo Chun Wen and Heinrich G. W. Begehr. Longman Scientific & Technical and John Wiley, 1990. xii + 411 pages.

This is volume 46 in the series Pitman Monographs and Surveys in Pure and Applied Mathematics. It deals with boundary value problems for linear and non-linear elliptic equations and systems by using function theoretic approaches. Amongst methods used to prove existence theorems are transformations of the general elliptic equations and systems into complex form, and integral representations of solutions to various boundary value problems are established. The book contains many recent results which have so far only appeared in the Chinese literature. The six chapters treat boundary value problems for: (1) simple complex equations, (2) elliptic first-order complex equations, (3) elliptic second-order equations, (4) elliptic equations and systems with piecewise continuous coefficients, (5) elliptic systems of two second-order equations, (6) elliptic systems of several equations.

Finite Element Approximation of Variational Problems and Applications. By M. Krížek and P. Neittaanmäki. Longman Scientific and Technical and John Wiley, 1990. 239 pages.

This is volume 50 in the series Pitman Monographs and Surveys in Pure and Applied Mathematics. It is a practical guide to the theory and application of the finite element (FE) method for solving various problems of mathematical physics. It extends the method to cover results in fields such as: superconvergence, FE-approximation to hyperbolic systems, nonlinear problems, bifurcation problems and dimensional reduction. The first half of the book is concerned with the solution of elliptic problems such as variational formulation in Sobolev spaces, discretization by FE, approximation of the boundary, numerical integration, assembling the stiffness matrix and solving the resulting system of linear algebraic equations; it also presents several methods for increasing the accuracy of the FE-solution. The second half of the book is concerned with the FE-approximation of time-dependent problems, contact problems in linear elasticity, Maxwell's and Helmholtz's equations, eigenvalue and bifurcation problems. Special emphasis is given to solving nonlinear problems with monotone operators. Numerical examples are given.

Stability Problems for Stochastic Models. Edited by V. V. Kalashnikov and V. M. Zolotarev. Springer-Verlag, 1989. 380 pages. \$33.00.

This is the Proceedings of the 11th International Seminar held in Sukhumi (Abkhazian Autonomous Republic), USSR, Sept. 25–Oct. 1, 1987. The texts of 27 lectures are included.

Continued on page 750

Continued from page 730

Regression Analysis: Theory, Methods, and Applications. By Ashish Sen and Muni Srivastava, Springer-Verlag, 1990. ix + 347 pages. \$39.00.

This is a volume in the series Springer Texts in Statistics. It arose from notes for a semester-long course at the University of Toronto, given to undergraduate and graduate students in various fields, including statistics, pharmacology, engineering, economics, forestry, and the behavioral sciences. It offers an up-to-date account of the theory and methods of regression analysis and includes a large number of examples drawn from real life. Since the exercises and examples use over 50 data sets, a disk containing most of them is provided with the book. The book has twelve chapters. The Gauss-Markov conditions are assumed to hold in the discussion of the first four chapters; the next five chapters present methods to alleviate the effects of violations of these conditions. The final three chapters discuss the related topics of multicollinearity, variable search and biased estimation. An appendix covers nonlinear regression. Relevant matrix and distribution theory is surveyed in two appendices.

Network Modeling, Simulation, and Analysis. Edited by Ricardo F. Garzia and Mario R. Garzia, Marcel Dekker, 1990. 392 pages. \$99.75.

This is volume 61 in the series Electrical Engineering and Electronics. It was written for the purpose of compiling, in a single volume, a series of topics falling within the general area of network modeling, simulation, and analysis for both circuit-switched and data networks. It also serves the purpose of presenting some recent work in the areas of compartmental models for the analysis of communication networks, closed-form solutions for the evaluation of network performance measures, adaptive routing and design for reliable distributed networks, and mixed voice/data networks. Many of the techniques discussed in the book have applications in other areas of science and engineering, for example, biological and manufacturing systems. Portions of the material covered were presented at an IEEE workshop in Tampa, March 1984. The twelve chapters are divided into four parts: 1. Modeling and simulation; 2. Computer networks; 3. Wide area communication networks; 4. Mixed voice/data networks.

Deducibility and Decidability. By R. R. Rockingham Gill. Routledge, Chapman and Hall, 1990. viii + 162 pages. \$47.50.

This monograph, derived from courses taught by the author over several years, is an exposition of the classic results obtained by Gödel, Tarski, Kleene, and Church in the early 1930's. This exposition of the results attempts a systematic unification of theory by choosing as the central notion one grounded in the semantics of the existential quantifier, and takes care to stress the importance of three things: the mathematically well-understood conversion of implicit to explicit definitions, the philosophically perplexing idea of self-reference, and their surprising disclosure as two aspects of one phenomenon by the Recursion Theorem.

Approximation and Optimization. Edited by A. Gómez, F. Guerra, M. A. Jiménez and G. López. Springer-Verlag, 1988. 280 pages. \$25.70.

This is the Proceedings of an International Seminar held in Havana, Cuba, January 12-16, 1987. It contains the texts of six invited lectures, fifteen papers on approximation theory, and four papers on optimization theory.

Continued on page 764

Continued from page 750

Chaotic Dynamics—An Introduction. By G. L. Baker and J. P. Gollub. Cambridge University Press, 1990. ix + 182 pages. (cloth) \$49.50, (paper) \$17.95.

This book is written as a short text, at a level accessible to sophomore/junior level undergraduate students of mathematics, engineering or physics, the subject being introduced through the study of the driven pendulum. It assumes elementary multivariable calculus, linear differential equations, and introductory physics. Listings, in BASIC, of useful programs are included. A menu-driven runtime package is available on a diskette. Chapter headings: 1. Introduction; 2. Some helpful tools; 3. Visualization of the pendulum's dynamics; 4. Toward an understanding of chaos; 5. The characterization of chaotic attractors; 6. Concluding remarks.

Computable Set Theory, Volume I. By Domenico Cantone, Alfredo Ferro, and Eugenio Omodeo. Oxford University Press, 1990. xii + 347 pages. \$59.95.

This is volume 6 in The International Series of Monographs on Computer Science. It has a foreword by Jacob T. Schwartz. The aim of this book is to automate simple proofs over a sufficiently wide range of mathematical areas to make computer-checked proof practical, in the sense of no longer requiring manual inputs which are far more tedious than careful person-to-person (or published) mathematical proof would require. Chapter headings: 1. Introduction; 2. Classes and orderings; 3. The validity theorem; 4. A partial solution to the finite satisfiability problem; 5. Elementary syllogistics; 6. Multilevel syllogistics; 7. Restricted quantifiers, ordinals, and ω ; 8. The powerset operator; 9. Map constructs; 10. The uniset operator; 11. The choice operator. Chapters 8 through 11 constitute the part labelled Extended Multilevel Syllogistics.

Freedom in Machinery, Volume 2: Screw Theory Exemplified. By Jack Phillips. Cambridge University Press, 1990. xiv + 251 pages. \$89.95.

The scope of this second (final) volume of the work is apparent from the chapter headings, numbered consecutively from the first volume: 11. Geometrical properties of the linear line systems; 12. The vector polygons for spatial mechanisms; 13. On the two theorems of three axes; 14. Some reciprocities across the middle number three; 15. The generality and the geometry of the cylindroid; 16. The discovery in a mechanism of a cylindroid; 17. Action, notion, clearances and backlashes; 18. Singular events in the cycles of motions; 19. Fundamental relations and some algebraic methods; 20. The special geometry of some overconstrained loops; 21. The helitangent lines in a moving body; 22. The cylindroid in gear technology; 23. The general and the special screw systems.

Abstract Analytic Number Theory. By John Knopfmacher. Dover Publications, 1990. 352 pages. \$9.95.

This is a corrected and enlarged republication of the work originally published by North-Holland Publishing Company in 1975 as volume 12 in the North-Holland Mathematical Library. Topics treated include arithmetical semigroups, arithmetical functions, semigroups satisfying axiom A , the abstract prime number theory theorem, Fourier analysis of arithmetic functions. The extensive bibliography has been greatly enlarged for this edition.

Continued on page 790

Continued from page 764

Finsler Geometry and Applications. By Aurel Bejancu. Ellis Horwood Limited, 1990. 198 pages. \$59.50.

This is a volume in the Ellis Horwood Series in Mathematics and Its Applications. It is a translation from the Romanian, edited by David E. Blair. The study of spaces endowed with generalized metrics was initiated by P. Finsler in 1918, and since then many important results have been achieved with respect to both the differential geometry of Finsler spaces and its application to variational problems, theoretical physics and engineering. The present book has a twofold purpose: to show that Finsler geometry is in fact mainly based on the geometry of the vertical vector bundle and to explain some of its applications to physics and continuum mechanics. Chapter headings: 1. Finsler geometry on the tangent bundle of a manifold; 2. Submanifolds of Riemann-Finsler manifolds; 3. Gauge theory on the tangent bundle; 4. Gauge theory on a fibre bundle; 5. Multi-dimensional physical theories as gauge theories on a fibre bundle; 6. A new geometrical framework for a multi-dimensional relativity theory; 7. Differential geometry of a supermanifold as a Finsler geometry; 8. Finsler geometry and deformation of oriented media.

Seismology and Plate Tectonics. By David Gubbins. Cambridge University Press, 1990. vii + 339 pages. (cloth) \$59.50, (paper) \$27.95.

This text grew from an undergraduate course at Cambridge; it concentrates on the development of seismology since the introduction of the World Wide Standardised Network in about 1960 and its role in the development of plate tectonic theory. Since reading seismograms is an excellent way to learn about the earth, several examples of seismograms have been included in the book, together with practical exercises for locating earthquakes, identifying different seismic phases and free oscillations, and determining the nature of the earthquake source. Chapter headings: 1. Introduction; 2. Mechanics of elastic media; 3. Elastic waves in simple media; 4. Earth structure and earthquake location; 5. Free oscillations; 6. The seismic source; 7. Plate tectonic theory.

Robust Estimation and Testing. By Robert G. Staudte and Simon J. Sheather. John Wiley and Sons, 1990. xix + 351 pages. \$54.95.

This textbook provides an introduction to the theory and methods of robust statistics at an intermediate level. It is intended specifically for students in senior undergraduate or first-year graduate statistics courses. The primary goals of the text are first, to convince the student of the need for robust statistics; second, to provide him with practical methods for carrying out robust procedures in a variety of statistical contexts; and third, to develop the techniques and concepts that are likely to be useful in the future analysis of new statistical models and procedures. In particular, the text emphasizes the concepts of breakdown point and influence function of an estimator. It demonstrates the technique of expressing an estimator as a descriptive measure, from which one may easily derive its influence function. The latter is then used to explore the efficiency and robustness properties of the estimator. Mathematical techniques are complemented by Minitab macros for finding bootstrap and influence function estimates of standard errors of the estimators, robust confidence intervals, and robust regression estimates and their standard errors, as well as P -values for various robust tests. A floppy disk accompanies the book, containing (as does the appendix) the data sets analyzed in the book and the above-mentioned Minitab macros. Chapter headings: 1. The field of statistics; 2. Estimating scale—finite sample results; 3. Estimating scale—asymptotic results; 4. Location-dispersion estimation; 5. Testing for a location parameter; 6. The two-sample problem; 7. Regression.

Continued on page 796

Continued from page 790

Hamiltonian Systems: Chaos and Quantization. By Alfredo M. Ozorio de Almeida. Cambridge University Press, 1990. ix + 238 pages. \$24.95.

This is a volume in the Cambridge Monographs on Mathematical Physics. The author has aimed to provide a concise introduction to the basic concepts of the field in unsophisticated mathematical language. Most of the classical theory in the first six chapters (Part I) deals with local motion. Periodic orbits, the fixed points of a Poincaré map, provide the unifying theme. Part II (Chapters 7–9) is devoted to the semiclassical limit of quantum mechanics. Chapter headings: 1. Linear dynamical systems; 2. Nonlinear systems; 3. Chaotic motion; 4. Normal forms; 5. Maps on the circle; 6. Integrable and quasi-integrable systems; 7. Torus quantization; 8. Quantization of ergodic systems; 9. Periodic orbits in quantum mechanics.

Matrices and Linear Transformations, Second Edition. By Charles G. Cullen. Dover Publications, 1990. 336 pages. \$7.95.

This is an unabridged, corrected republication of the second edition (1972) of the work originally published in 1966 by Addison-Wesley Publishing Company. It is directed to sophomore/junior undergraduates in mathematics, engineering and the physical sciences. The major objects of study are matrices over an arbitrary field. Among the key features are coverage of spectral decomposition, the Jordan canonical form, the solution of the matrix equation $AX = XB$, and over 375 problems, many with answers.

Differential Equations—Their Solution using Symmetries. By Hans Stephani. Edited by Malcolm MacCallum. Cambridge University Press, 1989. xii + 260 pages. (cloth) \$44.50, (paper) \$17.95.

This text is an elementary introduction to the theory and application of the methods invented by Sophus Lie for the integration of differential equations when their symmetries are known. The first fourteen of the 25 chapters deal with ordinary, the remainder with partial differential equations. Many examples are discussed and the book contains more than 100 exercises. It is easily accessible to beginning graduate students in physics, applied mathematics and engineering.

Combinatorial Optimization. Edited by B. Simeone. Springer-Verlag, 1989. iv + 312 pages. \$32.60.

This is volume 1403 of Lecture Notes in Mathematics and presents the lectures given at the third session of the Centro Internazionale Matematico Estivo (C.I.M.E.) held at Cuomo, Italy, August 25–September 2, 1986. There were four invited lectures, by Peter L. Hammer, Ellis L. Johnson, Bernhard Korte, and Eugene L. Lawler, as well as eight contributed papers.

Probability Theory on Vector Spaces IV. Edited by S. Cambanis and A. Weron. Springer-Verlag, 1989. 424 pages. \$37.50.

This is the Proceedings of a Conference held in Lancut, Poland, June 10–17, 1987. There are 34 papers.