# QUARTERLY

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# QUARTERLY OF APPLIED MATHEMATICS

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

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

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

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**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 that 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

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*Modelling Biological Populations in Space and Time.* By Eric Renshaw, Cambridge University Press, 1993, xvii+403 pp., $29.95 (paper)

This is the first paperback edition of volume 11 in the series Cambridge Studies in Mathematical Biology, first published in 1991. It develops an approach to the study of the dynamic behaviour exhibited by many species of plants, insects and other animals which unifies two approaches: that by theoreticians who model purely in terms of sophisticated mathematical equations, and biologists who develop simple deterministic models, reluctant to accept stochastic ideas. The authors show that both deterministic and stochastic models have important roles to play and should therefore be considered together; and they construct simple model-based computer simulation procedures which provide insight into the underlying generating mechanism, highlight hitherto unforeseen features of a process and thereby suggest further profitable lines of biological investigation. They advocate the view that the environment has a spatial dimension, since individual population members rarely mix homogeneously over the territory available to them but develop instead within separate sub-regions. Chapter headings: 1. Introductory remarks; 2. Simple birth-death process; 3. General birth-death process; 4. Time-lag models of population growth; 5. Competition processes; 6. Predator-prey processes; 7. Spatial predator-prey systems; 8. Fluctuating environments; 9. Spatial population dynamics; 10. Epidemic processes; 11. Linear and branching architectures.

*Modern Heuristic Techniques for Combinatorial Problems.* Edited by Colin R. Reeves, John Wiley and Sons, 1993, xiii+320 pp.

This book is designed to be a comprehensive review of some of the more recently developed strategies implementing heuristic techniques. All these techniques have been inspired to some sense by the realization that attempting to imitate natural processes can bring valuable insights to the problem of combinatorial optimization. The articles are by John Beasly, Kathryn Dowsland, Fred Glover, Manual Laguna, Carsten Peterson, Colin Reeves, Bo Söderberg, and their headings are, respectively, Introduction, simulated annealing, Tabu search, genetic algorithms, artificial neural networks, Lagrangean relaxation, evaluation of heuristic performance.

*Nonlinear Parabolic and Elliptic Equations.* By C. V. Pao, Plenum Press, 1992, xv+777 pp., $125.00

This book is intended to give a systematic treatment of the basic mathematical theory and constructive methods for a class of nonlinear parabolic and elliptic differential equations as well as their applications to various reaction-diffusion problems. The mathematical problems under consideration include scalar boundary-value problems of parabolic and elliptic equations, integroparabolic and integroelliptic boundary-value problems, and coupled systems of parabolic and elliptic equations. The boundary conditions for these equations may be linear or nonlinear, including nonlinear boundary conditions of integral type. The fundamental approach to all of these problems is the method of upper and lower solutions and the associated monotone iterations. This approach leads not only to the basic results of existence, uniqueness, and multiplicity of solutions, but also to various qualitative properties of the solution through suitable construction of upper and lower solutions. This method is also adaptable to constructing numerical solutions of the corresponding discrete systems. Extensive discussion is also given to the stability analysis and the asymptotic behaviour of time-dependent solutions, and attention is given to models arising in ecology, biochemistry, enzyme kinetics, combustion theory, and chemical and nuclear engineering. A special topic is the finite-time blow-up problem for parabolic equations. The book consists of twelve chapters; the first seven chapters treat the scalar parabolic and elliptic boundary-value problems and the remaining five chapters are concerned with coupled systems of parabolic and elliptic equations.

*Nonlinear Dynamics, Chaos and Econometrics.* Edited by M. Hashem Pesarian and Simon M. Potter, John Wiley and Sons, 1993, xiii+244 pp., $55.00

This book, a special publication of the *Journal of Applied Econometrics*, consists of an introduction by the editors and fourteen papers on various aspects of nonlinear time series analysis in economics. Recently, economic theorists have examined whether nonlinearity in the specification of a deterministic economy can produce solution paths that appear "random" to traditional linear techniques. This volume consists of contributions by leading researchers to this emerging field. The chapter headings are: 1. Complex economic dynamics: obvious in history, generic in theory, elusive in data; 2. Using the correlation exponent to decide whether an economic series is chaotic; 3. Lyapunov exponents as a nonparametric diagnostic for stability analysis; 4. The likelihood ratio test under nonstandard conditions; testing the Markov switching model of GNP; 5. Merger waves and the structure of merger and acquisition time series; 6. Nonlinear dynamics in a structural model of employment; 7. Characterizing nonlinearities in business cycles using smooth transition autoregressive models; 8. Forecast improvements using a volatility index; 9. Multivariate nearest-neighbour forecasts of EMS exchange rates; 10. Nonlinear time-series analysis of stock volatilities; 11. Threshold arch models and asymmetries in volatility; 12. News effects in a high-frequency model of the sterling-dollar exchange; 13. Intra-day futures price volatility: information effects and variance persistence; 14. The comparative power of the TR test against simple threshold models.

*Chaotic Dynamics — Theory and Practice.* Edited by T. Bounti, Plenum Press, 1992, xii+418 pp., $110.00

This is volume 298 in the NATO Advanced Science Institutes Series B: Physics. It contains the proceedings of a NATO Advanced Research Workshop held July 11–20, 1991, in Patras, Greece, which brought together scientists representing many of the different aspects of chaotic dynamics. There are 37 papers, divided into two parts, those on theory and those on practice. Within the theoretical papers, there are four general areas with 3–5 papers in each: (i) complexity, control and data representation; (ii) fractals, multifractals and analyticity of normal forms; (iii) integrability, Painlevé property and singularity analysis; (iv) statistical physics, celestial mechanics and cosmology. The "practical" papers are divided into four groups with 5–7 papers in each: (i) controlling dynamical systems; (ii) semiconductors, superconductors, lasers and electronic circuits; (iii) biology, chemistry, atmospheric and magnetospheric dynamics; (iv) Hamiltonian dynamics, dissipative dynamics and normal forms.

*Measure Theory.* By J. L. Doob, Springer-Verlag, 1994, xii+210 pp., $49.00

This is volume 143 in the series Graduate Texts in Mathematics. In this very personal monograph, written with verve and a perspective gained from the vantage point of great original achievement, the author stresses the following points: (i) the application of pseudometric, rather than metric, spaces, which obviates the artificial replacement of functions by equivalence classes, a replacement that makes the use of "almost everywhere" either improper or artificial. (ii) Probability concepts are introduced in their appropriate place, not consigned to a "ghetto", since mathematical probability is an important part of measure theory and offers a wide range of measure theoretic examples and applications both in and outside pure mathematics. (iii) Convergence of sequences of measures is treated both in the general Vitali-Hahn-Saks setting and in the mathematical setting of Borel measures on the metric spaces of classical analysis. Chapter headings: 0. Conventions and notation; 1. Operations on sets; 2. Classes of subsets of a space; 3. Set functions; 4. Measure spaces; 5. Measurable functions; 6. Integration; 7. Hilbert space; 8. Convergence of measure sequences; 9. Signed measures; 10. Measures and functions of bounded variation on $\mathbb{R}$; 11. Conditional expectations, martingale theory.