# QUARTERLY

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# APPLIED MATHEMATICS




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# QUARTERLY OF APPLIED MATHEMATICS

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

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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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0033-569X(200006)58:2;1-N

*Spectral/hp Element Methods for Computational Fluid Dynamics.* By George Em Karniadakis and Spencer J. Sherwin, Oxford University Press, 1999, x+390 pp., $75.00

The authors' aim in writing this book is to introduce a wider audience to the use of spectral/*hp* finite element methods with particular emphasis on their application to unstructured meshes. These methods incorporate both multi-domain spectral methods and also high-order finite element methods. The authors provide a unified description of both methods building on previously published works as well as on new material not previously published. Recently, the need to find accurate solutions to the viscous flow equations around complex aerodynamic configurations has led to the development of high-order discretization procedures on unstructured meshes. High-order discretization is also recognized as more efficient for solution of time-dependent oscillatory solutions over long time periods, for example, in the new field of computational electromagnetics in aerospace design. Chapter headings: 1. Introduction; 2. Fundamental concepts in one dimension; 3. Multidimensional expansion bases; 4. Multidimensional formulation; 5. Geometrically non-conforming elements; 6. Advection equation; 7. Helmholtz equation; 8. Incompressible flows; 9. Flow simulations; 10. Compressible flows. There are appendices on background material and a bibliography with 256 items.

*Statistical Data Analysis with Applications from Particle Physics.* By Glen Cowan, Oxford University Press, 1998, xiv+197 pp.

This is a volume in the series Oxford Science Publications. It is a guide to the practical application of statistics in data analysis as typically encountered in the physical sciences and, in particular, in high-energy particle physics. It developed out of work with graduate students at CERN. Chapter headings: 1. Fundamental concepts; 2. Examples of probability functions; 3. The Monte Carlo method; 4. Statistical tests; 5. General concepts of parameter estimation; 6. The method of maximum likelihood; 7. The method of least squares; 8. Method of moments; 9. Statistical errors, confidence intervals and limits; 10. Characteristic functions and related examples; 11. Unfolding. This last chapter concerns the distortions to distributions that occur when the values of random variables such as particle energies, decay times, etc., are subject to additional random fluctuations due to the limited resolution of the measuring device. The procedure of correcting for these distortions is known as unfolding.

*Topological Methods in Hydrodynamics.* By Vladimir I. Arnold and Boris A. Khesin, Springer-Verlag, 1998

This is volume 125 in the series Applied Mathematical Sciences. The group most often dealt with in hydrodynamics is the infinite-dimensional group of diffeomorphisms that preserve the volume element of the domain of fluid flow. This monograph—the first of its kind—studies topological features of flows with complicated trajectories and their applications to fluid motions. It touches upon hydrodynamic stability theory, Riemannian and symplectic geometry, magnetohydrodynamics, theory of Lie algebras and Lie groups, knot theory, and dynamical systems. Applications of this approach include topological classification of steady fluid flows, description of the Korteweg-de Vries equation as a geodesic flow, and results on Riemannian geometry of diffeomorphism groups, explaining, for instance, why, from this point of view, long-range dynamical weather forecasts are not reliable. Chapter headings: 1. Group and Hamiltonian structure of hydrodynamics; 2. Topology of steady fluid flows; 3. Topological properties of magnetic and vorticity fields; 4. Differential geometry of diffeomorphism groups; 5. Kinematic fast dynamo problems; 6. Dynamical systems with hydrodynamic background.

*Dynamical Systems and Semisimple Groups—An Introduction.* By Renato Feres, Cambridge University Press, 1998

This is volume 126 in the series Cambridge Tracts in Mathematics. The theory of dynamical systems may be described as the study of the global properties of groups of transformations. In some of its recent developments, the theory is concerned with the dynamics of more general groups than the additive group of real numbers, particularly semisimple Lie groups and their discrete subgroups. This book comprises a systematic, self-contained introduction to the work of G. A. Margulus and R. Zimmer and provides an entry into current research. The author develops the main results on Lie groups, Lie algebras and semisimple groups, including topics such as integration of infinitesimal actions of Lie groups. He derives the basic structure theorems for the real semisimple Lie groups, such as the Cartan and Iwasawa decompositions. He gives an extensive exposition of the general facts and concepts from topological dynamics and ergodic theory, including detailed proofs of the multiplicative ergodic theorem and Moore's ergodicity theorem.

*Performance Modelling with Deterministic and Stochastic Petri Nets.* By Christopher Lindemann, John Wiley and Sons, 1998

This text provides an up-to-date treatment of the fundamental techniques and algorithms for numerical analysis of deterministic and stochastic Petri nets, and the application of this modelling formalism to performance analysis of parallel computer architectures. It is accompanied by a CD-ROM containing the object code of the software package DSPNexpress for several hardware platforms, and specification files of a variety of deterministic and stochastic Petri net models. The eleven chapters of the text are divided into four parts: I. Introduction to performance modelling; II. Deterministic and stochastic Petri nets; III. Performance analysis of multiprocessor systems; IV. The software package DSPNexpress.

*Methods of Mathematical Finance.* By Ioannis Karatzas and Steven E. Shreve, Springer-Verlag, 1998, xv+407 pp., $69.95

This is volume 39 in the series Applications of Mathematics: Stochastic Modelling and Applied Probability. It is intended for readers who are quite familiar with probability and stochastic processes but know little or nothing about finance. It is written in the definition/theorem/proof style of modern mathematics and attempts to explain as much of the finance motivation and terminology as possible. The authors suggest that the reader be familiar with the material contained in the first three chapters of their book *Brownian Motion and Stochastic Calculus.* In the present book, Chapter 1 sets up the generally accepted, Brownian motion driven model for financial markets. Chapter 2 lays out the theory of pricing and hedging contingent claims ("derivative" securities) in the context of a complete market. Chapter 3 takes up the problem of a single agent faced with optimal consumption and investment decisions in the complete version of the market model in Chapter 1. Chapter 3 assumes that there are several individuals in the economy, each behaving as described in Chapter 3, their collective actions (through the law of supply and demand) determining the equilibrium prices of securities in the market. Chapter 5 turns to the issue of pricing and hedging contingent claims in markets with incompleteness or other constraints on individual investors' portfolio choices. Chapter 6 uses the approach developed in Chapter 5 to treat the optimal consumption/investment problem for such incomplete or constrained markets, and for markets with different interest rates for borrowing and investing.