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REVIEWS

Bifurcations in Flow Patterns. By P. G. BAKKER. Kluwer, 1991. 209 pp. £44.50 or $72.

Nonlinear Systems. By P. G. DRAZIN. Cambridge University Press, 1992. 317 pp. $79.95 or £40 (hardcover), $29.95 or £17.95 (paperback).

The theory of global properties of solutions of nonlinear differential equations has achieved significant advances in the past decades especially through the work of Russian mathematicians. To fluid dynamicists this progress is welcome in more than one respect. The field of nonlinear dynamics which encompasses much of the new developments has opened new views and approaches in the understanding of hydrodynamic instabilities and turbulent fluid flow. In a more direct way, the geometric theory of ordinary differential equations (ODEs) has provided a description of the properties of steady flows. Indeed, 'flow' has become the preferred technical term used by mathematicians to describe the evolution of trajectories in the phase space of solutions.

The first of the above-cited books is devoted to the latter subject. The author starts with an introduction to the topological properties of solution paths in the n-dimensional phase space of systems of n ODEs. The mathematical development follows the book *Qualitative Theory of Second-Order Dynamical Systems* by Andronov, Leontovich, Gordon & Maier (Wiley, 1973) and explicit examples are restricted to the two-dimensional case, for which a complete theory of singularities exists. In a second chapter the general theory is applied to conical flow patterns, which have important applications in the theory of supersonic flows around obstacles. The third and final chapter treats the topological properties of steady two-dimensional flows described by the Navier–Stokes equations. New results on laminar separation bubbles, flow separation at moving walls and the formation of asymmetric standing eddies in wakes are included in this chapter.

The book is useful as a carefully written introduction to the geometric aspects of the theory of steady flows. But some readers will be disappointed to find little reference to the structures of three-dimensional steady flows, which have been the subject of much recent research. This omission is also regrettable from a more general philosophical point of view, since the two-dimensional structures portrayed in the book are not always topologically stable against small perturbation in the three-dimensional world. A more careful editing of the book could have eliminated most of the numerous misprints and the occasional grammatical errors.

The book by Professor Drazin on nonlinear systems is one among many that have recently appeared on this fashionable subject. But there are a number of features which should make this book especially attractive to students of fluid mechanics and physics. Although the book is almost exclusively devoted to mathematics, the mathematical formalism is kept to a minimum. Few theorems are stated, and proofs are often replaced by examples which make the general principles plausible. Students and teachers will like this book, which is very readable, includes numerous problems and exercises, and covers virtually everything that can be expected from a textbook on the theory of nonlinear systems with few degrees of freedom. Even some typical examples of partial differential equations are included in an appendix.

A great virtue of the book is that concepts like map, fractal, strange attractor or chaos are introduced in a systematic way. In contrast to more traditional textbooks on this subject, *Nonlinear Systems* starts with bifurcations, maps and difference equations before a discussion of nonlinear ODEs is given in the second part. The reader thus becomes acquainted with general topological properties before they are applied to the solutions of the more familiar differential equations. The classification of bifurcations in two or more dimensions, the logistic equation and iterated maps in the complex plane, Mandelbrot and Cantor sets, and renormalization group theory are topics of the first four chapters of the book. Four more chapters on ODEs follow in the second part, with the van der Pol equation, the Lorenz system and the Duffing oscillator as the principal examples. But this enumeration is far from exhaustive and should just give an idea of the scope of the book. In fact, the author has been able to cover an impressive range of material by delegating many applications to the extensive problem sections. Analytical and numerical methods are emphasized throughout the book, and a few short codes written in BBC-BASIC are included which the reader can easily implement on his personal computer.

The book is addressed to final-year undergraduate or first-year graduate students, but it will be useful to any theoretically inclined researcher in the physical sciences. Since most chapters are self-contained and organized in subsections, the book can be used as a source of reference, for which the well-stocked index provides a convenient entry. Only the mathematical notation used in the discussion of Sarkovskii's theorems has remained somewhat obscure to this reviewer. In this connection it is worth mentioning that the Feigenbaum constants also apply to the $2^n \cdot k$-cycles for $k = 3, 5, \ldots$ in contrast to what is said in the book. The text is almost free of misprints and the quality of figures (including several coloured ones) and printing reflects the traditional high standards of the Cambridge University Press. With its more moderate price tag the paperback edition is likely to become a 'best seller' in its field.

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SHORTER NOTICES

Continuum Mechanics and Thermodynamics. Edited by K. HUTTER (Darmstadt) and I. MÜLLER (Berlin). Springer. Vol. 1 in 1989.

Theoretical and Computational Fluid Dynamics. Edited by M. Y. HUSSAINI (NASA Langley, Virginia). Springer. Vol. 1 in 1989.

International Journal of Engineering Fluid Mechanics. Edited by N. P. CHEREMISINOFF (Exxon, New Jersey). Gulf Publishing. Vol. 1 in 1989.

Waves in Random Media. Edited by A. ISHIMARU (University of Washington, Seattle). Institute of Physics Publishing. Vol. 1 in 1991.

International Journal of Numerical Methods for Fluids. Edited by R. W. LEWIS and C. TAYLOR (University College, Swansea, UK). Wiley. Vol. 1 in 1991.

Chaos, Solitions and Fractals. Edited by M. E. NASCHIE (Cornell University, New York). Pergamon. Vol. 1 in 1991.

International Video Journal of Engineering Research. Edited by V. R. VOLLER (Institute of Technology, Minneapolis). Wiley. Vol. 1 in 1991.

Computational Fluid Dynamics Journal. Edited by K. OSHIMA (Tokyo). Japan Society of Computational Fluid Dynamics. Vol. 1 in 1992.

It is of course impossible to review a journal as one does a book. Publication of a book marks the end of the author's work, but publication of the first numbers of a journal represents only the beginning. All one can do is to announce a new journal, and wish there were not quite so many already in existence. The above list gives some of the newcomers of the past three or four years having some connection with fluid mechanics.

Computational Methods in Hypersonic Aerodynamics. Edited by T. K. S. Murthy. Kluwer, 1991. 491 pp. Df 260.

This is one of a series of collaborative works with the general title Computational Mechanics Publications, others being *Computational Methods in Potential Aerodynamics* (1986) and *Computational Methods in Viscous Aerodynamics* (1990). It contains 12 articles by different authors, and although they are called chapters this is not a book with a continuous systematic thread. The first article is a useful introduction to the physical aspects of hypersonic aerodynamics, and the next two describe general computational methods for hypersonic flow, but after that each author writes on a particular aspect, presumably chosen according to his specialist interests. The style of the camera-ready copy varies from one article to another, and so too does the style of references and the system of numbering equations. It does not make for smooth reading, but it might be acceptable as a state-of-the-art contribution in a rapidly developing field.

Applied Numerical Methods with Software. By S. Nakamura. Prentice-Hall, 1991. 570 pp. $58.

This book constitutes a comprehensive introduction to numerical algorithms for science and engineering students. The range of topics is very wide indeed and, unlike many texts of a similar level of mathematical sophistication, it covers in some depth the numerical solution of partial differential equations. The choice of specific numerical methods is at times eclectic – it occasionally includes algorithms that are of mainly historical interest (Bairstow's method for zeros of polynomials), as well as relatively new ideas with little computational experience behind them (exponential methods for stiff ordinary differential equations). This is perhaps inevitable in a compendium of a large number of diverse and alternative methods for a wide spectrum of mathematical problems. The exposition is clear, computer programs help to highlight important implementational details and the author succeeds in conveying the intuition behind different computational approaches. The level of mathematical sophistication is basic – perhaps too basic to convey an important point, namely that 'number crunching' is neither a replacement for nor a palliative to mathematical reasoning. The two go hand in hand, and numerical methods should be underpinned by mathematical understanding. To be fair, depth and sophistication cannot coexist with wide coverage in a volume of manageable length. The exact compromise between depth and width must be ultimately left to teachers of numerical analysis, and this volume would be useful to those whose preference leans towards width.

Fractals and Chaos in Geology and Geophysics. By D. L. Turcotte. Cambridge University Press, 1992. 221 pp. £29.95 or $54.95.

The major aim of this book is to introduce undergraduates in the earth sciences to the concepts of fractals and chaos, along with aspects of dynamical systems, and their application to geological and geophysical systems. The book is divided into 17 chapters. The first two very briefly define the ideas of scale invariance and then fractals via the standard examples of Cantor sets, Koch islands and the length of coastlines. There then follow chapters on applications to the fragmentation of rocks, the frequency of earthquakes as a function of their magnitude and the relationship between size and quality of mined ore. The next chapters extend some of the theoretical concepts and relate fractal distributions to probability densities. There follow short chapters which introduce the reader to dynamical systems and logistic maps, which are illustrated in a chapter on the slider-block model for earthquakes. A discussion of the Lorenz equations and their relevance to the modelling of convection in the mantle and the Earth's dynamo follows. The main part of the book ends with a one-page evaluation of what the introduction of fractals has achieved. The page includes the comment 'today many scientists regard fractals and chaos as passing fads'. This is the only place in the book where any criticism of the techniques or their application is noted. Most of the chapters end with a few short problems. In summary, this is a clear and concise presentation of the author's current firmly held beliefs on the usefulness of fractals.

The following volumes of conference proceedings have also been received.

The Global Geometry of Turbulence. Edited by J. Jiménez. Plenum Press, 1991. 372 pp. $105.

The Mathematics of Oil Recovery. Edited by P. R. King. Oxford University Press, 1992. 817 pp. £95.

Recent Developments in the Physics of Fluids. Edited by W. S. Howells and A. K. Soper. Institute of Physics Publishing, 1992. 336 pp. £56.

Numerical Simulation of Unsteady Flows and Transition to Turbulence. Edited by O. Pironneau, W. Rodi, I. L. Ryhming, A. M. Savill and T. V. Truong. Cambridge University Press, 1992. 516 pp. £35.

Fluid Sealing. By B. S. Nau. Kluwer, 1992. 724 pp. Dfl 335.

Fluid Power Systems: Modelling and Control. Edited by C. R. Burrows and K. A. Edge. Wiley, 1992. 392 pp. £92.

Numerical Simulation of Compressible Euler Flows. Edited by A. Dervieux, B. V. Leer, J. Periaux and A. Rizzi. Vieweg, 1989. 357 pp. £39.95.

Numerical Simulation of 3-D Incompressible Unsteady Viscous Laminar Flows. Edited by M. Deville, T.-H. Le and Y. Morchoisne. Vieweg, 1992. 149 pp. DM 88.

Ordered and Turbulent Patterns in Taylor–Couette Flow. Edited by C. D. Andereck and F. Hayet. Plenum, 1992. 357 pp. $95.