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# REVIEWS

**Computational Analysis of Polymer Processing.** Edited by J. R. A. PEARSON and S. M. RICHARDSON. Applied Science Publishers (Elsevier), 1983. 343 pp. £36.00.

One criterion for judging the success or failure of a book is the extent to which it achieves the objectives of its authors and/or editors. The subject matter of this book is computational analysis of polymer processing, as stated in its title, and the editors state their objective as giving "as useful and connected account as we can of a wide class of applications, for the benefit of scientists and engineers who find themselves working on polymer processing problems and feel the need to undertake such calculations". In pursuing this objective, Pearson and Richardson employ the somewhat unusual method of having each chapter written by an "acknowledged expert", much in the spirit of a handbook. The advantages claimed of this approach are that each chapter will tend to be self-contained so that an "occasional reader" can begin with any one of them without need to refer backward to earlier material, and that the editors can enlist a set of authors who can provide a more authorative discussion of their areas of special interest than could have been elicited from any one person who attempted to cover the whole set of topics. The inevitable variety in the presentation might be viewed as welcome by some readers (as suggested by the editors), but will be disconcerting to others and a definite disadvantage, in my opinion, to the reader who may wish to use the book as a basis for studying the whole subject rather than one special topic.

The book contains nine chapters with titles and authors as follows:

1. Introduction: Polymer Melt Mechanics, by J. R. A. Pearson, 19 pp.;
2. Computational Techniques for Viscoelastic Fluid Flow, by M. J. Crochet and K. Walters, 42 pp.;
3. Extrudate Swell, by R. I. Tanner, 28 pp.;
4. Extrusion (Flow in Screw Extruders and Dies), by R. T. Fenner, 45 pp.;
5. Moulding, by S. M. Richardson, 39 pp.;
6. Fibre, Spinning, by M. M. Denn, 37 pp.;
7. Film Blowing, Blow Moulding and Thermoforming, by C. J. S. Petrie, 24 pp.;
8. Coating Flows, by S. F. Kistler and L. E. Scriven, 46 pp.;
9. Process Control, by J. Wortberg, 34 pp.

With the possible exception of Chapter 9, which seems misplaced in the present volume, all of these chapters are concerned primarily with the mechanics of polymer processing flows, and are of potential interest to readers of *JFM*. It is perhaps inevitable that a reviewer with active research interests encompassing a number of the topics of a book will find detailed points of disagreement with the author(s), and I found that to be true in this case. Equally likely is a fast moving field such as this, there will be instances where the opinions of the author(s) are dated before they are in print, and that is also true to a minor degree in this book – particularly in the discussions of numerical methods for viscoelastic materials that appear in the later chapters. However, neither of these is a serious deficiency.

My main reservations about this volume are more general in character. Specifically, it appears to me that it will be useful only as a supplement to other books or research reviews, and then only to a highly selective audience. In order to understand much of the material in anything but a superficial way, the reader will need a rather sophisticated understanding of rheology and non-Newtonian fluid mechanics, of polymer processing and of current methods of numerical analysis in fluid mechanics, before he or she begins. The subject of the book is really the intersection of these three basic topics, yet none of them is covered in a self-contained manner. Chapter 2 on computational techniques provides a closest approach in the area of numerical analysis. The descriptions of the various polymer processing operations are almost always too succinct to give anything like an overview of the key physical elements of the particular process or a basis to judge the relevance of the idealized model problems which are actually studied numerically. One may legitimately argue that this type of incisive judgment is more in the realm of the author than the reader, but it is not a responsibility that is uniformly accepted by all of the authors of the present volume. The discussions of the rheological aspects of the various processes, and of the computational simulations of these processes, is perhaps the most uneven feature of the book. In some cases, the motivation for use of a particular constitutive model is reduced to a few sentences. None except the most sophisticated and up-to-date researchers in rheology or non-Newtonian fluid mechanics will understand why a particular choice has been made, and even then the decision may not be obvious with the exception of computational expediency when the model adopted is that of a Newtonian fluid. This is the type of critical insight which may be inaccessible to the newcomer who "feels the need to undertake...calculations" of polymer processing flows, and one would have hoped and expected it to be forthcoming from the distinguished panel of authors that have contributed to this volume.

The quality of the authors insures that this book will be of interest to readers of *JFM* with particular interests in polymer processing or non-Newtonian fluid mechanics, and it can be recommended on that basis. It is not, however, a book that can be recommended for the general fluid dynamicist who seeks to learn something of polymer processing, or, for example, the numerical analyst who wishes an introduction to applications in the area of non-Newtonian fluid mechanics. Least of all is it appropriate as a text for students unless they are already intimately familiar with polymer processing, rheology, and numerical analysis, as indicated above.

L. G. Leal

**Perturbation Methods in Applied Mathematics.** By J. Kevorkian and J. D. Cole. Springer, 1981. 558 pp. DM 96.

This book is based on *Perturbation Methods in Applied Mathematics* by J. D. Cole (Ginn/Blaisdell, 1968) and, while it contains most of the material in the original, it also contains a wealth of new material. For example, the original had 260 pages, the new one has 558 pages. The original book presented easily accessible introductions to several topics in perturbation theory, and so it was quite useful as a principal text or at least a major supplementary text for a course in perturbation theory. This version has lost some aspects of accessibility. Consequently, it does not replace the original, which is unfortunately out of print, but it will probably be viewed as being an important reference book for such a course.

There are some inconvenient features of the book's format. First, it would be quite useful to have a more detailed table of contents. The present one stops at the section headings, but much valuable information about the book's organization lies in the subsection headings. Secondly, a common bibliography would be helpful. The majority of citations are inconveniently placed at the end of sections, and the short list of general references at the end of the book would be helped by citing some additional general reference books; e.g. Whitham's book on Nonlinear Waves (it is cited in a section bibliography), Wasow's book on Asymptotic Expansions, which contains careful treatments of turning-point problems that are dealt with in this book, Erdelyi's book on Asymptotic Expansions, which fills in many important asymptotic methods not treated here, Arnol'd's books on Differential Equations and Mechanics, which are handy general references for many of the topics in this book, and Van Dyke's book on Perturbation Methods in Fluid Mechanics (listed in Section 3.1).

The general outline of the book remains the same. The first chapter discusses concepts of asymptotic expansions, and the second treats matching methods for initial- and boundary-value problems for ordinary differential equations. Particularly important in the second chapter is the detailed work on relaxation oscillations. This is one of the book's highlights. Also welcome is the new material on collision orbits.

The third chapter (Multivariable Expansion Procedures) is 225 pages long. It was approximately 40 pages long in the original, where it made multivariable methods quite accessible by solving specific problems in a straightforward way. The new version requires a great deal of editing to extract the original approach.

A valuable addition to the third chapter is the section on applications to satellite problems. Several interesting topics and calculations are presented in this section, and they give a welcome introduction to perturbation methods in celestial mechanics. This section is a useful source for classroom material.

The third chapter closes with a short discussion of the place multivariable methods hold among averaging methods. Considering the length of this chapter, the closing discussion should be more complete. For example, it is remarkable that a treatment of averaging does not mention books by Arnol'd, Moser, Hale and Stoker. In particular, these references describe small-divisor problems and how various stability conditions overcome them. Since small divisors form a major obstacle to constructing approximations in highly oscillatory systems, some discussion of them should be included in the book.

The remaining two chapters are readable and very useful. These make up about one-third of the book. Chapter 4 (Applications to Partial Differential Equations) presents a variety of problems encountered in dealing with singular perturbations of partial differential equations. Its treatment of second-order equations should be familiar to anyone working in perturbation theory. Chapter 5 (Examples from Fluid Mechanics) works through three classic examples (from acoustics, shallow-water waves and thin-airfoil theory) that nicely illustrate how matching methods have been used.

In summary, this book represents a substantial enlargement and updating of the original one by Professor Cole. It preserves many important features of the original book, while at the same time it presents several novel and interesting examples. This book is an indispensible reference for people working with perturbation methods and for students learning perturbation techniques. One of its most important aspects is the detailed treatment of examples coming from a variety of applications, mostly in fluid mechanics. This kind of treatment is difficult to find in today's literature.

F. C. HOPPENSTEADT

SHORTER NOTICES

**Topics in Ocean Physics. Proceedings of the International School of Physics 'Enrico Fermi', Course 80.** Edited by A. R. OSBORNE and P. MALANOTTE-RIZZOLI. North-Holland, 1982. 550 pp. Dfl255.00.

This volume covers material presented during a two-week course held in the summer of 1980, at Varenna in northern Italy. The first of four sections is on the dynamics of mesoscale and large-scale flows. It contains a survey of midocean eddies; an account of two-dimensional and geostrophic turbulence theory; the use of, and results from, surface-drifting instruments; and an extensive coverage of planetary solitary-wave theory and numerical experiments. Solitons also feature in the second section, entitled 'nonlinear phenomena of waves on deep water'. A good summary of recent advances is followed by papers on theory, experiments and field observations. The third section contains just one article, about the physics and simple models of mixed-layer dynamics. In the last section linear models of ocean surface waves are discussed, with emphasis on statistics and computer simulation techniques. The articles are generally well written, ranging from the simple introductory level to the highly technical (not always in that order!), giving good, if somewhat repetitive, coverage of the main topics. The book itself is of high quality.

**Magnetic Field and the Processes in the Earth's Interior.** Edited by V. BUCHA. Academia, Prague, 1983. 514 pp.

The Czechoslovakian Academy of Sciences has collected together in this volume the contributions of a large number of authors from Eastern Europe and the Soviet Union. The articles are of a more or less review nature and cover a wide range of topics in geomagnetism. The problems of compiling such a volume have meant that there has been a considerable delay in publication: the most recent reference to a paper in print is 1979. The first chapter contains a lengthy discussion of the data from modern observations as well as archeomagnetic and paleomagnetic measurements. The major part of the chapter is concerned with a spectral analysis of the secular variation. Evidence is presented for the spectrum being discrete, and prominent periods ranging from 11.5 to 30000 years are identified with varying degrees of confidence. This is followed by comparisons of many measurements of field reversals. Detailed analysis of the ancient data is of course severly limited by the poor and very scanty data set, but some attempts to model the field are discussed in chapter 2. The third chapter begins with a very readable review of dynamo theory (including an objective look at the data) by S. I. Braginsky. This is followed by more detailed discussion of the alternative theoretical approaches (the nearly axisymmetric dynamo and mean-field electrodynamics) and other selected topics (mantle conductivity, bumps on the mantle–core boundary, and a review of precession as a dynamo power source). The final chapter contains more on mantle conductivity and a summary of what is known about the magnetic fields of the other planets. There is also much further discussion of the data including attempts to identify features of the data with processes proposed to be taking place in the core. The conclusions drawn must of course be seen in the light of the poor quality of the data and our present understanding of the fluid mechanics of the core.

**Asymptotic Treatment of Chemically Reacting Systems.** By A. K. Kapila. Pitman, 1983. 119 pp. £16.50.

This useful little book seeks to introduce research workers in chemical engineering and combustion to the asymptotic analysis of singular perturbation problems, to help them acquire more insight into the dominant physical processes at work and avoid expensive and unnecessary computations. The first chapter briefly outlines the methods of matched asymptotic expansions and of multiple scales, illustrating their practical application by means of particular examples for which exact solutions exist. Chapter 2 (40 pp.) is entitled 'activation-energy asymptotics', dealing with exothermic reactive systems which obey the Arrhenius law of chemical kinetics and have large activation energies. Topics considered include ignition and extinction in a one-dimensional reaction–diffusion system and the propagation of small-amplitude plane waves in a reactive gas. Chapter 3 is concerned with isothermal systems: a jump phenomenon caused by poisoning of catalyst, and the transient diffusion and reaction of two initially unmixed reactants. Chapter 4, 'Oscillations', examines the bifurcation of oscillatory states from stationary solutions, considers the effect of weak diffusion on the evolution of a reactive system that already supports limit-cycle oscillations, and investigates the forced oscillation of a reactor whose steady-state response exhibits hysteresis. In all cases the physics of the system is introduced only in a brief formulation; the emphasis throughout is on how to use asymptotic methods in practice.

**Annual Review of Fluid Mechanics, Volume 16.** Edited by M. Van Dyke, J. V. Wehausen and J. L. Lumley. Annual Reviews Inc., 1984. 444 pp. $28.00.

The 15 articles that make up this year's volume are as follows: 'Karl Pohlhausen, as I remember him', Knox Millsaps. 'Wave action and wave–mean flow interactions, with application to stratified shear flows', R. Grimshaw. 'The deformation of small viscous drops and bubbles in shear flows', J. M. Rallison. 'Numerical solution of the nonlinear Boltzmann equation for nonequilibrium gas flow problems', S. M. Yen. 'Numerical simulation of turbulent flows', Robert S. Rogallo & Parviz Moin. 'Nonlinear interactions in the fluid mechanics of helium II', H. W. Liepmann & G. A. Laguna. 'Secondary flow in curved open channels', Marco Falcón. 'Vortex shedding from oscillating bluff bodies', P. W. Bearman. 'Modern optical techniques in fluid mechanics', Werner Lauterborn & Alfred Vogel. 'Stability and coagulation of colloids in shear fields', W. R. Schowalter. 'Aeroacoustics of turbulent shear flows', M. E. Goldstein. 'Computer-extended series', Milton Van Dyke. 'Dynamic parameters of gaseous detonations', John H. S. Lee. 'Supercritical airfoil and wing design', H. Sobieczky & A. R. Seebass. 'Perturbed free shear layers', Chih-Ming Ho & Patrick Huerre.