BOOK REVIEWS

Numerical Computation of Internal and External Flows, Volume 1: Fundamentals of Numerical Discretization
C. Hirsch
John Wiley & Sons, Ltd., 1988

Volume 1 of this book is aimed at introducing the reader to the essential steps involved in the numerical simulation of fluid flows. The whole book consists of four parts: mathematical models for fluid flow simulations, basic discretization techniques, the analysis of numerical schemes, and the resolution of discretized equations. The discretization techniques introduced in this book are finite difference, finite element, and finite volume methods, but the spectral discretization methods are omitted.

The stability problem is discussed in Chapters 7 through 10. Chapter 8 gives a detailed discussion about the Von Neumann analysis. Chapters 9 and 10 discuss the method of equivalent differential equation and the method of matrix, respectively, both of which are found to be quite useful as more generalized stability analyses.

Many fundamental concepts are presented clearly and in an understandable way. The operator method is one of the unique approaches that many other competitive books do not have.

This book may be suitable for graduate courses and for scientists who are already engaged in computational fluid dynamics.

R. S. Amando

Handbook of Numerical Heat Transfer
Minkowycz, Sparrow, Schneider and Pletcher, Eds.
John Wiley & Sons, Ltd., 1988

The idea of creating a *Handbook of Numerical Heat Transfer* is a good one, and the editors deserve to be commended for their initiative and effort.

The Handbook attempts mainly to present available numerical methods for solving parabolic, elliptic and hyperbolic partial differential equations which govern the transport of momentum and energy in flows with heat transfer.

While the Handbook contains some of the well known numerical methods, it stops short of providing guidance to the reader as to which method best suits his specific problem. For example, there are four methods (Chapters, 2, 3, 4 and 5) for solving parabolic problems, and six (Chapters 6, 7, 8, 9, 10 and 11) for elliptic problems. Yet nowhere can the reader find a guide for selecting the appropriate one among these methods, or a list of the advantages and disadvantages of each method. I should emphasize here that these ten chapters describe their respective numerical procedures quite well and serve as a useful reference for them.

Because of the lack of user guidance, the Handbook is missing the main ingredient that would attract readers to a Handbook on numerical methods. I find this inconsistent with the editors' claim in the preface that 'From the very outset, it was the intent of the editors that the Handbook be user-friendly and that it accommodate various audiences ranging from relative beginners to experienced practitioners.' I do believe that this goal has not been accomplished.

A few of the 22 chapters are exempt from the above criticism, most notably the three chapters on hyperbolic and hyperbolic–parabolic systems, finite-difference versus finite-elements, and moving boundary problems. The authors of these chapters provide comparisons of the different methods of solving their respective problems with ample references.

The chapters on graphics and grid generation serve as reasonable introductions to these subjects.

This more-than-thousand-page volume contains much to be learned by practicing engineers, and perhaps the editors may wish to improve the Handbook in future editions.

S. Elghobashi

Viscous Flows: The Practical Use of Theory
Stuart Winston Churchill
Butterworths Series in Chemical Engineering, 1988 $52.95 602 pp.

This book, in spite of its general title, is essentially devoted to laminar, incompressible momentum transfer, primarily by analytic solutions, and subsequent comparison to experimental data. The book does not treat turbulent flow, compressible flow, heat transfer, mass transfer, flow instability, or numerical modeling. There is quite a bit of inviscid flow included, in spite of the book title, but very little boundary layer theory. There is a very good section on porous media.

The book is intended as a textbook for both a first-year graduate course or, with some material omitted, for a first undergraduate fluids course. It is based on the author's notes in his 35 years of teaching. There are over 700 problems for students, most rather brief but some quite challenging. There is apparently no Solutions Manual.

The author claims to introduce seven distinct characteristics in the presentation: (1) extensive use of simple theories; (2) developing skill in deriving theories; (3) comparison with experimental data; (4) use of asymptotic and correlating expressions; (5) focus on behavior rather than mathematics; (6) all derivations from first principles; and (7) emphasis on physical and quantitative understanding. These are, of course, similar to the goals set by authors of most engineering books. The author is especially successful with items 1, 3, and 4.

The book is divided into four parts, beginning with 130 pages (7 chapters) on one-dimensional laminar flows, derived and solved by simple "shell" balances. Non-Newtonian flows are included. Topics include tubes, channels, films, and Couette flows, each compared with an amazing amount of laminar-flow data.

Part 2, 120 pages long, treats the general equations, first derived and then applied to a variety of exact solutions, including inviscid and creeping-flow cases. Both differential and integral forms are considered. Derivations can be sketchy, sometimes strikingly so. For example, the Newtonian stress/strain-rate relations are simply inserted as "empirical expressions" which have "never been confirmed experimentally in the general sense." Stokes' hypothesis appears but is not explained. There is no energy equation, just mass and momentum. To the reviewer's knowledge the words *stress* and *strain-rate* are not mentioned in the book. An interesting variety of analytical solutions is given, but it is a somewhat confusing mixture of viscous and inviscid flows whose possible connection through, say, boundary layer theory is not emphasized.

Part 3 devotes 248 pages to "Unconfined Multidimensional Laminar Flows," including the flat plate, wedges and discs, two interesting chapters on the circular cylinder and the sphere, and a very good 70-page chapter on bubbles and droplets. The boundary layer equations are simply stated without derivation as "due to the usual simplifying assumptions ... originated by Prandtl." The discussion of similarity is very good. Integral methods are discussed briefly and stated to be "now only of historical interest." Boundary layer series solutions are discussed, but no numerical methods are presented.

The fourth section devotes 83 pages to dispersed solids, including porous media, sedimentation, fluidized beds, and bubbles in emulsions. These two chapters present a great deal of interesting data. Finally, there is a one-page appendix and both an author and a subject index.

The printing is sharp and excellent. Although figures have been borrowed from many sources, often without re-drawing, they are bright and clear. The reviewer found only two misprints, in Equation 8.8 and Figure 13.13.

Although the book covers only certain types of laminar flows, it is well written and should be especially useful to chemical engineers. The author intends it to join his three companion books on inertial flows, multi-dimensional laminar flows, and turbulent flows.

Frank M. White

Practical Thermodynamic Tools for Heat Exchanger Design Engineers

H. Soumerai
John Wiley & Sons, Inc., 1987

The stated purpose of this book is to encourage engineers and researchers to consider the application of equilibrium and nonequilibrium thermodynamics tools that are available today in the solution of heat exchanger engineering problems. This book is a new look at our understanding of heat transfer and pressure drop and relates both to thermodynamic concepts, some long forgotten by the practicing engineer. Relevant fundamental concepts, definitions and theoretical concepts, and theoretical assumptions are formulated into 29 guidelines that identify the significant thermodynamic characteristics of the heat exchangers used in the air conditioning and refrigeration industries (low thermal-lift heat exchangers). However, the author also describes the use of these tools for high thermal-lift heat exchangers and for heat exchangers used in the power industry (feedwater heaters and surface condensers) and in ocean thermal energy conversion systems.

The guidelines apply to both laminar and turbulent single-phase flow in smooth and roughened channels and to two-phase flow in condensers and evaporators. Both counter and parallel flow exchangers are considered. The thermodynamic concepts of reduced properties and the second law driving force—the entropy difference—are refreshing and new concepts proposed for the arsenal of tools for the heat exchanger engineer. The methods developed for problem solutions are also applied to practical design cases.

The book is aimed at practicing heat transfer engineers and for teachers and researchers of thermal sciences. The practicing heat exchanger engineer will benefit because of the return to basic concepts and generous use of numerical analyses that reveal the magnitude and significance of quantities such as the Reynolds number that are lost when using typical heat exchanger rating computer software. The many references to the historical basis for the fundamental laws and the empirical relations make it valuable material for all persons dealing with thermal sciences. This book would also be a suitable undergraduate text for a course dedicated to heat exchanger design because of the interdisciplinary approach of a unified thermodynamic treatment of momentum and heat transfer.

The book is very well organized, free of errors, and very easy to read. The writer does not overwhelm the reader with profound mathematics and uses both U.S. customary and SI units. Unfortunately, practicing engineers today must use both unit types and the writer was fully aware of this real-world situation. Noteworthy is the very logical organization of the material and how each chapter is a self-contained unit so the reader can select the material sequence consistent with his individual needs and/or interests.

This book is a must for the libraries at universities, government laboratories, and at companies involved with the use and/or design of heat transfer equipment. In addition, this book is well worth purchasing, reading, and having in a personal library because many thermodynamic concepts, germane to heat exchanger design have been forgotten by most practicing engineers, myself included.

T. Rabas

Fluid Mechanics, second English edition (Vol. 6 of the *Course of Theoretical Physics* by the same authors.)

L. D. Landau and E. M. Lifshitz
Pergamon Press, 1987

The *Course of Theoretical Physics* by Landau and Lifshitz is a ten-volume classic, a remarkable memorial to the confidence and breadth of its authors, and the time in which they lived.

Both Landau and Lifshitz are now dead; Landau, the senior author, died in 1968 at the age of 60 and Lifshitz, his student, died in 1985 at the age of 68. The second English translation of the volume on fluid mechanics, volume 6, was published in 1987, nearly 30 years after the first English edition of 1959.

We in fluid mechanics know of Landau and Lifshitz possibly from first hand study, and certainly through references by others to its basic equations, its examples of analytical solutions or its unusual topics and lines of reasoning. Has the later English edition added much to what we already had in the 1959 version?

The answer is no. If one is particularly interested in stability mechanisms, then the three new sections on frequency locking, strange attractors and period doubling may be worth noting. But they will not provide an adequate view of these subjects since they omit most of the results of computer solutions for model equations which illustrate these phenomena. A few other new sections have been added, usually amplifications of material treated in the earlier version. A chapter on "Fluctuations in Fluid Mechanics" added to the first English edition when it was translated from Russian, has been dropped from the second English edition. Little of interest has been lost or added, and the new volume is much the same as its predecessor.

Landau and Lifshitz is more of a reference book than a textbook, despite the formally worked problems throughout the text. These problems form a convenient source of examination questions for certain graduate courses in fluid mechanics, perhaps a good reason for having the book accessible to both graduate students and professors!

But the book is unusual, representing a view of fluid mechanics from a theoretical physics standpoint. Consider for example the discussion, partly in footnote form, of a possible diffusion of mass resulting solely from a density gradient. What would be the implications of such a mass diffusion coefficient? And how many of us have ever thought about the implications?

Who would expect to see the Zhukovskii (Joukowski) theorem discussed in a chapter on turbulence, or induced drag described in a chapter on boundary layers? And what other fluids book would have "Relativistic Fluid Dynamics" or "Dynamics of Superfluids" among its topics?

The references scattered in footnotes and in the main body of the text are quite