Springer Handbook of Experimental Mechanics

By C. Tropea, A. L. Yarin, J. F. Foss, Springer-Verlag, Berlin, 2007, 1557 pp., $199.

This multi-authored book is part of the Springer Handbook Series, and follows the general philosophy of this series. More specifically the editors of this volume wanted to cover the planning, executing and interpreting of fluid mechanics experiments. Part A (2 chapters) is devoted to the foundations of fluid mechanics, i.e., equations and dimensional analysis. Part B (6 chapters) reviews the measurements of primary thermomechanical characteristics of flow. In part C, 13 application domains are considered. Clearly the editors had to make a selection here. The topics in the book range from polymer rheology over atmospheric measurements to combustion diagnostics. Finally, part 4 covers acquisition and processing of signals and data. The chapters or sections normally introduce briefly the basic concepts, present possible measurement techniques, and then discuss the measurement procedures and sometimes also possible problems and errors. This approach is essentially followed in all the chapters. It is unavoidable that the depth of the theoretical background and the treatment of measurement details vary. Some chapters are based on the property to be measured (e.g., pressure), whereas others are method oriented (e.g., density-based techniques). This could give rise to much overlap, which has been avoided here. One of the consequences is, however, that some topics are not found where they might be expected, e.g., thermocouples are not described under "Temperature and Heat Flux" but in the chapter on "Atmospheric Measurements". Use of the subject index does not solve this problem completely, it is recommended to use instead the PDF search possibility of the DVD version.

Layout, figures and execution in general of this book are very good. Exceptionally, sections contain a significant number of typographical errors.

This book is probably most useful in laboratories where occasionally flow measurements have to be performed that are outside their usual range. The book could then in many cases provide a first overview of possible techniques, as well as some insight in what the measurements involve. The extensive lists of references guides the reader to the specific literature.

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Advanced Fluid Mechanics

By W. P. Graebel, Elsevier, Amsterdam 2007, 362 pages, $89.95.

This book is a text based on courses taught by the author over a period of five decades, mostly at the University of Michigan. Its purpose is to introduce students to the subject of three-dimensional (3-D) fluid mechanics and classical theory. The book concentrates on the mathematical treatment of isothermal incompressible fluid dynamics, with an added introduction to basic computational fluid dynamics. It is a self-contained text aimed at senior undergraduate students and first-year graduate students.

The book starts with an elucidation of fundamental concepts such as velocity, acceleration, path lines, stream lines, stream functions, stress tensor, boundary conditions, vorticity, and of the basic equations of fluid mechanics, such as conservation laws, constitutive relations, hydrodynamic equations and possible use of a moving coordinate system. The book then proceeds with a serious and comprehensive mathematical exposition of irrotational flows. Chapter 2 shows how inviscid irrotational flows can be described in terms of a velocity potential and many basic 2-D and 3-D examples of potential flows are presented, as well as, relevant theorems for irrotational flow. Chapter 3 deals with the mathematical treatment of 2-D irrotational flows in terms of complex variables; again many interesting examples are presented. These two chapters provide the student with a considerable amount of information. The book also contains a chapter 4 on surface and interfacial waves. Chapter 5 gives a nice survey of cases for which exact solutions of the Navier-Stokes equations can be obtained. Like chapters 2 and 3, this chapter also covers many interesting examples, first when convective acceleration is absent, and then when convective acceleration is present. Chapter 6 deals with boundary-layer equations and their applications. This reviewer considers the contents in chapters 1–6 the essence of the applied mathematics of fluid mechanics treated in the book. That is, they seem to reflect topics that are close to the personal interest of the author. After some shorter chapters on forced and natural convection, on low Reynolds number flows, on flow stability, and on turbulence, the author proceeds to his second major goal by introducing the student to computational fluid mechanics in two more comprehensive chapters 11 and 12. Chapter 11 gives examples of computer programs in FORTRAN and discusses schemes for calculating derivatives and for numerical integrations of differential equations, all 1-D. Chapter 12 is an important chapter on multidimensional computational methods for dealing with elliptic, parabolic and hyperbolic differential equations. The book concludes with an appendix on vector and tensor calculus.

This reviewer was a bit confused about the meaning of "advanced" in the title before opening the book. The book is not a treatise dealing with advanced fluid dynamics if one expects it to provide the reader with an assessment of the status of the frontiers in the subject. The chapters on flow stability and turbulence give only limited information. To pursue frontier research in fluid mechanics the reader would need to consult books dealing with the topics of interest at a more advanced level. The book is still an introduction to fluid mechanics, albeit at the senior undergraduate and first-year graduate level. Also the book does not discuss many topics in fluid mechanics relevant in chemical engineering, such as hydrodynamic equations for mixtures, compressible flows, two-phase flows, non-Newtonian fluids. The book can be recommended as an introduction to isothermal incompressible potential flows and its complexities, as well as, providing a good introduction to numerical techniques for use in computational fluid dynamics. The book is suitable for graduate students in disciplines like physics, applied mathematics, mechanical engineering, and aerospace engineering, but less so for graduate students in chemical engineering.

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