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BOOK REVIEWS

Computational Fluid Dynamics Review 1995, edited by M. Hafez and K. Oshima. John Wiley & Sons, Chichester, U.K. (1995). ISBN 0-471-95589-2. US$125.

Computational Fluid Dynamics (CFD) is a highly interdisciplinary field and one of the most challenging areas of Computational Mechanics. By using the numerical simulation of complex flow patterns one can obtain a better physical understanding and it also can be used as a severe test case for any computational method. The increasing speed and expanded storage capacity of modern High Performance Computers (HPC), together with new advances in numerical algorithms, visualization and programming techniques, have greatly improved the ability to solve and visualize complex problems in fluid engineering (for example large scale and direct numerical simulation of flow problems).

There are at least five journals which publish articles in this important field (Theoretial and Coputational Fluid Dynamics, Computational Fluid Dynamics Journal, International Journal of Computational Fluid Dynamics, Computers & Fluids, and the International Journal for Numerical Methods in Fluids), as well as a considerable number of classical books and books of conference proceedings. The main objective of this book which distinguishes it from other publications in the field is that "it presents comprehensive survey and review articles which provide up-to-date information about recent progress in CFD". This obective meets the long standing need for survey and review articles in the CFD field. Professors Hafez and Oshima have generally succeeded in reaching their objective.

This volume contains 51 articles arranged in five chapters. The first chapter is on general topics and comprises five contributions by well-known leaders in the CFD field, namely: Professor Lax's article on the history of CFD at the Courant Institute; Professor Marchuk's article on progress in numerical methods at the Russian Academy of Sciences; Professor Godunov's article on Thermodynamics, Conservation Laws and Symmetric Forms; Professor Lions' contribution on the Controllability of Navier Stokes Equations, and Professor Kreiss' discussion on CFD limitations. Chapter 2 is on numerical methods and organized in six sections: Section 2.1 deals with grid generation and adaptation and consists of four articles (Automatic structured grid generation, Chimera and prismatic grid methods and unstructured mesh procedures); Section 2.2 is on central and upwind schemes and consists of nine articles (on higher order, flux splitting, and shock capturing finite difference schemes); Section 2.3 is on finite volume, finite elements, spectral and vortex methods and consists of four articles (on co-volume, finite element, spectral element and vortex methods); section 2.4 is on complex characteristics, fictitious domain, and Lagrangian methods and consists of three articles; Section 2.5 is on preconditioning and convergence acceleration techniques and consists of five papers (one deals with a pseudo-compressibility system, two are on preconditioned methods, one on conjugate gradient and one on multigrid method); Section 2.6 is on control and optimization problems and consists of four excellent papers by well known leader experts (Professors Jameson, Pironneau, Gunzburger and Dr Periaux). Chapter 3 is on flow physics and consists of seven articles (on transonic flow, flows with vortices, rotating flows and three articles on turbulent flows). Chapter 4 deals with interdisciplinary areas and consists of six articles on a wide range of problems (reacting flow, non-Newtonian and viscoelastic fluids, fluid structure interaction, acoustic and electromagnetic). Chapter 5 is on parallel computations and flow visualization and consists of four articles (three on parallel computation and one on visualization).

Professors Hafez and Oshima are to be congratulated for their enormous task in compiling and editing the CFD Review 1995 series. The presentation and layout of this book is of a very high quality and standard, thus making it convenient for the reader to follow.

However, there are a few points which this reviewer feels should be taken into consideration, namely:

(1) It would be preferable to focus on specific relevant issues and publish it quarterly rather than have all the articles printed annually in one heavy volume (which is also, from a practical point of view, somewhat cumbersome to carry).
(2) Some of the articles written are not suitable to consider as review papers, since they do not give an overview on the specific topic.
(3) Some important methods such as the spectral method (it is rather disconcerting that there is no paper on pure spectral method!), finite element and visualization methods (there is only one paper written on this increasingly important field) have been inadequately represented.

The book should be of interest to computational mechanics experts engaged in developing CFD techniques, as well as to scientists and engineers who wish to use these techniques in order to solve their flow problems. The book can also serve as a library reference book.

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Physicochemical Hydrodynamics, 2nd edn, R. F. Probstein. John Wiley & Sons, New York (1994). ISBN 0-471-01011-1.

The field of physicochemical hydrodynamics (PCH) encompasses a vast spectrum of interdisciplinary topics in which fluid flow fields interact with particulate systems, chemical reactants, electrical fields, thermal fields, etc.

Diverse physical phenomena such as electrophoresis, electroosmosis, gel-chromatography, filtration, diffusion, sedimentation, coating and suspension stability underlie many industrial processes and are thoroughly described in the book. The book's second edition also introduces topics in rheology of concentrated suspensions, hydrodynamic chromatography, chemical reaction in electrokinetics and surface tension induced convection.

The book is rationally edited and 'user-friendly'. Every chapter can be read with very little reference to previous chapters and almost none to following chapters. The author's main goal is to stress the relevance of a given problem to many different industrial processes, emphasizing the underlying common basic physical concepts. Toward this end, he analyzes the competing forces that govern a process and the resulting non-dimensional parameters that determine the relative significance of the various physical mechanisms. The non-dimensional parameters are evaluated with real-life data pertaining to well established processes. Consequently, the assumptions made are sensible and well founded. The ensuing mathematical treatment is very clearly and accurately presented. It is, however, of lesser concern and in many cases the interested reader is referred to published references for in depth analysis. The problem sections following the main body of every chapter make the book useful as a graduate text. The problems are interesting and serve to further the reader's knowledge and enhance his or her understanding of the preceding chapters.

The writing style of Professor Probstein makes the book a pleasure to read. Readability and clarity are paramount and stem from the logical and simple wording and the short sentences that the author employs (in certain cases the formal English language is sacrificed on this altar). Notwithstanding, this is no book for beginners. Previous knowledge of low Reynolds number hydrodynamics is expected. A good grasp of basic concepts in electrostatics, thermodynamics and chemistry is also desirable.