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Book Reviews

Fundamentals of Computational Fluid Dynamics

H. Lomax, T. H. Pulliam, and D. Zingg, Springer-Verlag, Heidelberg, Germany, 2001, 249 pp., $49.95

Textbooks for computational fluid dynamics (CFD) typically attempt to balance their treatment of fundamental and applied aspects. The subject book, true to its title and intent, avoids this compromise by unabashedly concentrating on the former. The book has the simply stated but fairly ambitious goal of inculcating a "deep understanding of the fundamental principles." To this end, it focuses on mathematical foundations of numerical methods at a level suited to a first course at the graduate level. The book has its basis in the lecture notes of the late first author, who was unquestionably a venerated pioneer and champion for CFD. The emphasis on linear algebra and eigenanalysis reflects his philosophy.

Following the introduction, three rather concise chapters expose the foundations of conservation laws and model equations (Chapter 2), finite difference approximations (Chapter 3), and finite volume methods (Chapter 5). In choosing schemes for further dissection, the authors are careful to select mainly those that develop some concept or make some pertinent point: the plethora of essentially obsolete schemes found in some other introductory texts is (thankfully) absent. Given its origins, it is perhaps not surprising that the most outstanding feature of the book is the treatment of eigenanalysis of the semi- and fully discretized systems, which are covered in Chapters 4 and 6–9. These explore the elements of time-marching methods, relaxation methods, and the stability of linear systems in an orderly and cogent manner. Chapter 10, on the multigrid method, appears at first glance to be out of place, but further scrutiny reveals the motivation of the authors: to reinforce eigensystem concepts developed in earlier segments of the book. Chapter 11 deals with numerical dissipation, and this context is employed to outline upwind methods as well. The book returns to the subject of full discretizations in Chapters 12 and 13 by introducing and analyzing split and factored forms. The appendices present results from linear algebra and discuss properties of tridiagonal matrices and the degree-one homogeneous nature of the Euler equations.

The unaffected style adopted by the authors makes the book very readable and brings a surprising degree of freshness to the mature concepts that are its emphasis. For this reason, in addition to graduate students, the book may appeal to professionals who do not have formal training in CFD but who wish to learn more theory than is found in cookbook-oriented code manuals. With few exceptions, topics chosen for exposition reflect careful tailoring to meet the objectives of the book. The organization is reasonable, though the instructor may wish to alter the sequence of presentation. For example, it may be more logical to compare and contrast finite difference and finite volume methods by discussing them back-to-back rather than interjecting concepts related to semidiscrete methods in between.

A significant deficiency is the lack of a bibliography. Citations are indispensable to students seeking additional self-study topics or in fleshing out ideas for term projects, and attribution is of course important in technical publications. It is to be hoped that the authors will correct this oversight in subsequent editions. The uniqueness of the book—its sharp focus on ideas and analysis rather than tips and techniques—may also, depending on one's philosophy regarding a first course, be regarded as a weakness. The preface notes several topics of current interest that have been consciously excluded. The book thus makes minimal comment on computer implementation (such as round-off error and parallel processing), grid generation, unstructured methods, and turbulence modeling. Several topics, for example, upwind schemes, are summarized, whereas others, such as the multigrid method, may require augmentation with additional material. Figures and chapter-end problems are somewhat fewer than might be desired but are very illustrative nonetheless. The typesetting is of superior quality, and the price is consistent with what one might expect to pay for a hard-bound volume.

In summary, this book aims to expose the mathematical foundations of CFD at the level of a first graduate course. The authors have deliberately enforced strict limitations on range and scope, the better to emphasize the theory behind numerical methods within the timeless framework of linear algebra and eigenanalysis. As such, the authors have accomplished their goal by writing a focused and very useful textbook.

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Propellants and Explosives: Thermochemical Aspects of Combustion

Naminosuke Kubota, Wiley, New York, 2002, 245 pp., $115.00

This is a unique book. Written by an internationally known expert in the field, it attempts to explain the combustion of propellants and explosives at an elementary level. The background required of the reader is no more than basic chemistry and elementary calculus. The book could be appropriate for a special-topics course at the undergraduate level. This would be a survey type of course because there are no problems or examples to be worked through by the student. The later and more extensive chapters of the book also serve as a useful summary of various combustion properties of many different propellants and explosives. This authoritative summary can be especially helpful to scientists and engineers who wish to enter the field, as well as to seasoned specialists in search of a convenient although certainly not exhaustive compendium of information. The volume thus serves a dual purpose in its appeal to both students and experts. No other book is available with these characteristics that addresses the thermochemical aspects of the combustion of propellants and explosives.

The subtitle (Thermochemical Aspects of Combustion) is relevant because the presentation is tightly focused on combustion. The writing is terse and to the point, which is advantageous for an author whose native language is not English because the few inevitable awkward phraseologies do not disrupt the train of thought significantly. Especially the later chapters, which necessarily are more descriptive of details of combustion behavior and which relate more directly to the author's own research, are written in excellent English. Moreover, there are relatively few misprints to be found. The volume is attractively prepared, with numerous graphs and tables, as well as some relevant color photographs. It shows the attention to detail that might be expected from someone attempting to present the main results of his life's work to the newcomer.

After a one-page preface explaining the objective, the book begins with three chapters of background material. The first of these covers, in 19 pages, thermodynamics, shock waves, nozzle flow and performance parameters for air-breathers, rockets, and guns, all at the simplest and most elementary level. The second, in just nine pages, summarizes thermochemistry, and the third, which is appreciably longer, introduces deflagrations, detonations, and diffusion flames, presenting simplified models for deflagration structure and for one-dimensional burning of a solid, defining the relevant propellant parameters. The energetics and combustion products of many different propellants and explosives are presented in 40 pages in the fourth chapter, where the classifications of different types of energetic materials are made clear. The next four chapters, which contain the bulk of the detailed material to be found in the book, give much information on the combustion behavior of, first, crystals and polymers (starting, as might be expected, with ammonium perchlorate, proceeding through other materials, including HMX and TAGN, and ending with GAP and BAMO); second, double-base propellants (including effects of additives and catalysts); third, composite propellants of many types (emphasizing experimental results, with very brief discussions of some of the simplest burning-rate models); and fourth, explosives (very basic, in only six pages). These four chapters strive for physical explanations of observations and do not address any of the mathematical theories. The last chapter concerns combustion of solid propellants in rocket motors and in ducted rockets, covering information such as definitions of the basic types of combustion instabilities, ignition transients, erosive burning, and effects of embedding wires in the propellant. There are two short useful appendices, one summarizing conventional abbreviated names of energetic materials and the other standard strand-burner construction and operation.

This thin volume, carefully prepared and addressed to the neophyte, will be welcomed by many who are interested in the combustion of propellants and explosives. I welcome it.

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