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REVIEWS

Computational Techniques for Fluid Dynamics, Vols. I, II, Second Edn. By C. A. J. FLETCHER. Springer, 1991. Vol. I, 401 pp., DM65; Vol. II, 493 pp., DM75.

This is the second edition of the two-volume computational fluid dynamics (CFD) text, first published in 1988. The coverage is comprehensive and reliable, and the book has become a standard entry both as a teaching text and as a reference volume. The two-volume book is generally divided into a 'first course' in volume I, and a second volume that is 'of greater value after the individual has gained some CFD experience with his own project', as the author states in the preface. It has become something of a tradition for texts in CFD to include a chapter setting out the basic equations of fluid mechanics. It has also become a tradition for CFD texts to develop portions of the general theory of partial differential equations (PDEs). Fletcher's text conforms to these conventions: chapter 2 of volume I sets out the theory of PDEs, chapter 11 (the first of volume II) discusses the governing equations of fluid motion. One may wonder how the author has managed to postpone this discussion for so long. The answer is that volume I really could have been titled 'numerical PDEs'. Although most of the examples are derived from problems in fluid flow and heat transfer, the discussion is quite general. There are chapters on discretization, accuracy of finite-difference formulae, convergence of numerical methods, and so on. Weighted residual methods are the subject of chapter 5. In chapter 6 various techniques are pulled together in the solution of steady problems such as the two-dimensional Burgers equation and flow in a duct. Chapters 7 and 8 deal with one-dimensional and multi-dimensional diffusion, respectively. The issue of how to treat equations where the convection terms are dominant is taken up in chapter 9 where a number of methods are discussed: FTCS, upwinding, leapfrog, Lax–Wendroff, Crank–Nicholson, and aspects of operator splitting. The tradeoffs between implicit and explicit schemes are discussed, as are such issues as the cell Reynolds number and higher-order upwinding.

The 'real' CFD course starts in volume II. After chapters on the basic equations, curvilinear coordinates, and a rather useful chapter 13 on grid generation there follow five chapters: on inviscid flow (chapter 14), boundary layers (chapter 15), flows governed by reduced Navier–Stokes equations (chapter 16), incompressible viscous flow (chapter 17) and compressible viscous flow (chapter 18).

The discussion of inviscid flows starts with panel methods for incompressible flow and then moves on to supersonic flows. Shock-capturing techniques are treated: MacCormack's scheme and Moretti's λ-scheme are discussed in detail. The ideas of flux-corrected transport (FCT) and total variation diminishing (TVD) condition are mentioned. Implicit and multigrid schemes for Euler's equations are explained next. The chapter ends with a discussion of transonic flows.

Chapter 15 on boundary-layer flows leads naturally into chapter 16 on 'reduced' formulations, or 'parabolized' Navier–Stokes equations as many authors would call them. Both internal and external flow problems are discussed.

Chapter 17 on incompressible viscous flows introduces the 'Marker and Cell' (MAC) formulation, spectral methods, artificial compressibility, the SIMPLE (semi-implicit method for pressure-linked equations) formulation, finite elements, the vorticity–streamfunction variables in 2D and vorticity formulations for 3D flows.

Chapter 18 reaches the pinnacle of computable compressible viscous flows. Both explicit and implicit MacCormack schemes are discussed as are the Beam–Warming algorithm and other approximate factorization methods.

In summary, a book of considerable utility both in the classroom and as a reference volume has been produced. Several sample codes discussed in the text are listed, and output from many of them is used as a basis of the discussion of different topics, comparison of techniques, and so on. A bibliography (journal paper titles, unfortunately, are not given) broken down by chapters concludes the text. Fletcher's book is sure to become an invaluable tool for student and researcher alike, and a trusted introduction and guide to the rapidly evolving field of CFD.

HASSAN AREF

Topics in Fluid Mechanics. By R. CHEVRAY and J. MATHIEU. Cambridge University Press, 1993. 320 pp. £27.95.

This book was conceived as an introduction to fluid mechanics for graduate students. It has chapters on rheology, vorticity dynamics, turbulence, dynamical systems and chaotic advection, chaos and the onset of turbulence, boundary layers, wave propagation, and classical thermodynamics. I am intrigued by the educational problem of constructing an introduction for graduate students, for whom, as the authors observe, one can assume a higher level of mathematical preparation, skip over some fundamentals and proceed nearer to the frontiers of research. However, on reflection I am none too happy with what the authors have produced.

Obviously different teachers and graduate students with different backgrounds, say in engineering or in mathematics or in physics, would differ in their personal selection of topics. Contrary to the authors' warning, I do not think that the claimed integrated presentation would be a serious obstacle to the omission of one or two topics and the addition of others. Given that graduate students are better prepared, I was surprised that the opportunity was not taken to explain the important developments in computational fluid mechanics. However lightly one is recapitulating the basics, I would have found it essential to discuss the rôle of the Reynolds number (first mentioned on page 79, and then tangentially) and to give a derivation and simple application of the Bernoulli integral (the word 'Bernoulli' appears first on page 47, without explanation). With the exception of the two chapters on chaos, the authors have not exploited the freedom of a graduate text to include any recent research (nothing from at least the last 30 years so far as I can see). Although this is a personal expression of taste, my biggest disappointment was the suppression of practical applications – for me the challenge and the attraction of fluid mechanics is the construction of simple and quantitative predictions of everyday and industrial phenomena.

While I have no doubts that the authors started from a tried and tested lecture course, I fear that they have underestimated the effort and difficulty in converting their lecture notes into a carefully prepared textbook. There are mistranslations of French (for example 'put in evidence' on page 45 instead of 'demonstrate', and something remark-worthy is not 'remarkable' on page 214). There are slips in the equations (for example the conservation of mass has a curious minus sign on pages 21 and 218, and the magnetic induction equation changes on pages 229 and 230 from $\boldsymbol{j} = \operatorname{curl} \boldsymbol{B}$ to $\hat{\mu} \operatorname{curl} \boldsymbol{H} = 4\pi \boldsymbol{j}$ to $\operatorname{curl} \boldsymbol{H} = \boldsymbol{j}$). Material is poorly ordered [for example the momentum equation is used on page 17 before being derived on page 20 (with a different order of the subscripts), and Lagrangian (without a capital 'L') coordinates are introduced on page 48, totally ignoring their earlier presentation on page 2]. Some scientific statements are wrong (for example on page 33 one cannot deduce from $T_{xx} = T_{yy}$ that the Stokesian viscosity coefficient α_2 must vanish because $T_{zz} \neq T_{xx}$, moreover no known fluid has this rheological description in any limit; and in wave scattering on page 233, there should not be a source term in the governing equation, one appears only in the perturbation organization of the calculation). I found an average of three such silly slips per page in the chapters that I scrutinized carefully. Surely the publisher of this prestigious Journal could have provided expert editorial assistance in the final preparation of the text?

I regret that I do not think my graduate students would benefit from this book.

E. J. HINCH