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BOOK REVIEW

Computational Fluid Mechanics and Heat Transfer. By J. C. TANNEHILL, D. A. ANDERSON & R. H. PLETCHER. Taylor & Francis, 1997. 792 pp. ISBN 1 56032 045X. £58.

This is the second edition of a textbook which dates back to the early eighties, at a time when very few CFD textbooks were available. As a result, many of the first generation CFD users and developers are already familiar with the first edition. The 15 years that elapsed between the two editions saw an enormous growth in the methodologies as well as in the range of applications of CFD. Most chapters have been revised in the second edition to reflect this growth (e.g. multigrid techniques for Laplace's equation and high-order upwind total variation diminishing (TVD) schemes for hyperbolic partial differential equations – PDEs), the emphasis being on finite-difference and -volume methods.

The authors refreshingly take the attitude that experimental, analytical and numerical techniques are not in competition with each other. All three should be used in a complementary manner to tackle problems in fluid mechanics and heat transfer. A note on the brief history of CFD is also included in the introduction, which is very interesting and well worth reading.

The first part (which claims about a third of the nearly 800 pages of this book), deals with fundamental issues on the properties of PDEs, discretization techniques and their application to model problems. There is a brief but adequate revision of the physical and mathematical classification of PDEs, followed by a similar chapter on the basics of discretization methods, where some basic concepts from numerical analysis are introduced. The rest of this part is concerned with the application of numerical methods to model equations: wave, heat, Laplace's, and inviscid and viscous Burgers' equations. For each one of these equations there is a section on the physical system it relates to and on its mathematical properties. A good number of well-known methods are then described for solving the model PDE in question, with the aim of providing background to the more complex applications which follow in the next part of the book.

The second part addresses applications of numerical methods to the equations of fluid mechanics and heat transfer. The pattern is similar to that of the first part of the book in that the governing equations and their mathematical and physical properties are revisited before proceeding to detailed numerical matters. In this part an introduction to turbulence modelling and some transformation of the equations can also be found. Curiously, although this chapter is only concerned with the formulation and properties of the governing equations and there is no mention of numerical methods, a few pages can be found at the end outlining the finite-volume formulation. This is probably to accentuate the importance that the authors place on this formulation.

All but one of the remaining chapters of this part consider reduced formulations of the Navier–Stokes equations, namely the Euler equations for inviscid flow, the boundary-layer equations and the parabolized Navier–Stokes equations. The physical and mathematical properties of the governing equations are exposed before applying a number of numerical schemes for their solution. The final two chapters deal with the complete system of the Navier–Stokes equations for compressible and incompressible flows. I found particularly useful the section on the compressible system at low speeds, something missing from many other textbooks of similar content.

The concluding chapter is on grid generation. Of course this is a topic worth another 800 pages in its own right, but the authors manage to summarize very nicely the main approaches and provide information on more complex topics like adaptive grids, giving plenty of references for those interested in pursuing this topic further.

It would have been desirable to present more results using the numerical methods described in the text and comparisons with exact solutions, especially for time-dependent flows (although space restrictions may be an issue).

In summary, this is an excellent, well-written textbook which covers a very broad range of topics on the subject of the application of numerical methods to fluid flow problems. It would be valuable addition on the bookshelf of the CFD student or practitioner, which can be used as a teaching aid at graduate level or as a reference text for the academic researcher/industrial user.

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