BOOK REVIEWS

Finite Element Computational Fluid Mechanics

A. J. Baker

This book is an excellent introduction to its subject, aimed at students or practitioners of computational fluid dynamics (cfd) who do not have much background in structural analysis, the birthplace of the finite element method (fem). It is well known that the variational principles used for simple partial differential equations in structural analysis are not applicable to the more complicated equations of fluid dynamics, but in his two introductory chapters Baker rather skilfully passes from true variational principles to the error-minimisation process of generalised Galerkin methods (method of weighted residuals), holding the thread of minimisation of the 'energy' in the approximation error.

In the remaining six chapters on progressively more advanced applications, errors in simulating the convective-diffusive nature of the fluid dynamic equations are carefully discussed, and it is shown, for instance, that the phase lag of an fem based on linear variation within the elements (trapezoidal integration) is considerably smaller than that of the Crank–Nicolson finite-difference method based on parabolic fits to the solution, at least for a linear pure-convention problem. This is an advance on most previous expositions of fem for cfd, in which errors have received scant attention. The fem, like the finite difference method (fdm), typically requires some 'upwinding' (biasing of the convective term towards the upstream side of the element) to remove unphysical wiggles from the solution, and one should not blame the author because he can do no more than refer to the 'considerable literature' on the subject: upwinding for fdm is also currently a black art. Unfortunately there is not much discussion of comparative programming and computing times for fem and fdm.

The advantage of the fem is the ability to treat complicated geometries, apparently rather more simply than fdm or even finite volume methods with coordinate transformations. This advantage is at the expense of a more complicated algebraic formulation, traditionally based on matrix manipulation, which requires some effort to master. Jerry Baker's book minimises the effort required of the student, and should help to stimulate further development of the fem in fluid dynamics.

P. Bradshaw
Imperial College, UK

Published, price $39.50, by Hemisphere Publishing Corporation, Berkeley Building, 19 West 44 Street, New York, NY 10036

Numerical Methods in Laminar and Turbulent Flow

C. Taylor J. A. Johnson and W. R. Smith (eds)

This volume, containing the 108 papers presented at the 3rd International Conference on the title topic held in Seattle in August 1983, is a handsome production. The author-prepared typescripts are printed on thin, although adequately opaque, paper giving a book of comfortable proportion despite the 1260 plus pages.

The book actually reached my desk in advance of the conference so the editors and publisher have decisively overcome the common problem of conference volumes of being out of date before they reach the bookshops. In issuing the volume in advance of the meeting, however, the papers have inevitably been grouped under topic areas corresponding with those of technical sessions at the Conference itself. Now, the technical programme has been arranged some months in advance, based on abstracts submitted by the authors. To try and piece together a coherent programme from these sometimes obscure, sometimes downright misleading summaries is an impossible task. The editors thus have my sympathy that several of the papers seem wrongly located while others seem strangely out of place at an international symposium.

The papers are arranged in fourteen sections: laminar flow and lubrication; turbulent flow; boundary layers; flow with separation; estuary and coastline hydrodynamics; free surface flow; turbomachinery; driven cavity flow; non-Newtonian flow; free and forced convection; convection/diffusion; two/multi-phase flow; combustion; mathematical concepts and general applications. These topics are not all mutually exclusive and one finds in a number of cases—turbulent flow, for example—that more interesting papers on the subject in question are to be found under other sections.

For me, the two strongest impressions emerging from this collection are what considerable progress is being made in the application of finite element methods to recirculating and other complex flows (though a convincing near-wall numerical treatment in turbulent flow still seems lacking) and what great strides the various French laboratories have made in numerical fluid mechanics over the past ten years.

Despite the uneven quality of the papers, every research group active in numerical fluid mechanics will want to possess this book if only for its topicality and sheer volume.

B. E. Launder
UMIST, UK

Published by Pineridge Press Ltd, 91 West Cross Lane, West Cross, Swansea, West Glamorgan, UK