BOOK REVIEW

Turbulence Models and Their Applications – Vols 1, 2

J. Mathieu; D. Jeandel; B. E. Launder, W. C. Reynolds and W. Rodi

These two volumes comprise the lecture notes for a summer school organized by Electricité de France in 1982. The three years since the course was held have not been notably eventful ones in turbulence studies, and the material presented in these volumes is still adequately up-to-date. With the exception of Professor Reynolds' lectures, which give a good general introduction to turbulence modelling, these are reviews for the expert: the individual contributions are all lucid expositions of the authors' views, and since the authors are among the most distinguished workers on turbulence modelling their fellow workers will find these books extremely useful. However, although the contributions do not overlap significantly there is little useful interaction between them (although a common layout and notation are followed). Therefore, these volumes are to be regarded as a collection of authoritative monographs rather than as a coherent text book: indeed, the order of the contributions seems to have been dictated by non-scientific considerations, rather than following the order of increasing difficulty.

Volume 1 (in French), by Mathieu and Jeandel of the Ecole Centrale de Lyon, begins with the traditionally rigorous discussion of turbulence as a branch of statistical mechanics, and proceeds to discuss the 'spectral' or 'two-point' approach initiated by Craya and followed more recently by the Lyon school. It is a logical extension of the classical theory of unsheared homogeneous turbulence, associated with the names of Heisenberg and Kraichnan, for example, to more general sheared or strained flows, including inhomogeneous flows. In view of the unsatisfactory nature of length-scale equations in Reynolds-stress modelling, the two-point approach is very attractive, but closure is effected by assumptions of quasi-normality of the probability distribution, descended from those of classical homogeneous turbulence theory, such as the 'eddy-damped quasi-normal model', and in general less use is made of experimental data than in Reynolds-stress modelling.

Two-point or spectral methods may be the wave of the future, but at present the main stream of turbulence modelling is represented by Reynolds-averaged models, more or less closely based on the exact Reynolds-stress transport equations. Professor Launder's contribution is an admirable discussion of the state of this difficult art, with particular reference to the search for a suitable length-scale transport equation. His discussion of this point is based mainly on the dissipation equation, but he also discusses the multiple-length-scale approach pioneered by Schiestel and by Launder himself: he clearly feels that at present the two-length-scale approach is a better buy than the full spectral model of Mathieu and Jeandel.

Professor Reynolds' contribution is the nearest to a general review, having been prepared to 'serve as a primer for students of turbulence modelling and simulation'. Basic concepts and equations are reviewed in an illuminating way which even the expert will read with profit, and then used in a discussion of the physics and statistics of turbulence; leading, via a discussion of rapid-distortion theory, to presentation of a new model for homogeneous turbulence, a very brief overview of transport modelling (which is of course treated in depth elsewhere in the book) and finally a discussion of 'numerical simulations', comprising both full time-dependent solutions of the Navier Stokes equations for the eddy motions ('full turbulence simulations', or FTS) and their cheaper relation, 'large eddy simulation' or LES.

Professor Rodi's contribution, entitled 'Examples of turbulence model application', describes calculations for a very wide range of turgulent flows, based on the k, ε method but including comparisons with calculations by other methods where possible. Professor Rodi's own commentary on the results of the calculations is extremely helpful, but it is a pity that the other authors did not make more use of Rodi's results to illuminate their own contributions.

In summary, although these volumes collect the notes from a summer school, a graduate student will find them more useful for reference than for cover-to-cover reading: specialists will find them a useful compendium of the different schools of thought on turbulence modelling.

P. Bradshaw
Imperial College,
London, UK

Published price, 114.75 F, by Eyrolles, 61 Bd Saint-Germain, Paris 5e, France, Vol 1 223 pp, Vol 2 423 pp.