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BOOK REVIEW

Turbulent Flows

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+ Article information

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Abstract

It was a pleasure to read this important book. To understand and predict the development of turbulent flows represents both a continuing scientific challenge and also a serious practical problem in many different fields.

Professor Pope has based his book on graduate level lecture courses on turbulence that he has presented at MIT and at Cornell University. It is intended for students in engineering, applied mathematics, oceanography and atmospheric sciences, as well as researchers and practising engineers. The emphasis is on turbulent *flows*, rather than on the theory of homogeneous turbulence, and only constant-density, nonreacting flows are considered. The author states that his aim is to explain concepts and develop the necessary mathematical tools, rather than to provide a practical guide to turbulence modelling. The text is divided into two parts. *Part I* provides an introduction to turbulent flows and the fundamental physical processes involved. Topics discussed in separate chapters include: the equations of fluid motion, the statistical description of turbulent flows, the mean flow equations, free shear flows, scales of turbulent motion and wall flows. The chapter on statistical methods for turbulence is particularly good; together with the related appendices it represents a valuable and accessible introduction to the subject. Several approaches for modelling or simulating turbulent flows are then described in *Part II*, in which the various chapters describe direct numerical simulation (DNS), turbulent viscosity models such as the k-ε model, Reynolds stress and related second-moment models, probability density function (pdf) models and large-eddy simulation (LES) techniques. Finally, some necessary mathematical tools are summarized in ten Appendices dealing with a wide range of relevant topics including tensors, Dirac delta functions, Fourier transforms, random processes, derivation of pdf equations, characteristic functions and stochastic descriptions of diffusion processes.

I particularly enjoyed the chapters on modelling and simulation of turbulent flows. A unified treatment of the different types of model has enabled the author to make

valuable connections between them and to reach clear and logical conclusions about the strengths and weaknesses of each approach. Over many years Professor Pope has made very important contributions to the development and application of pdf methods for the prediction of nonreactive and also reactive turbulent flows. The chapter on this subject is an exceptionally clear description of these powerful and often under-utilized simulation methods. The final chapter, on LES, provides an excellent introduction, with valuable and novel insights into both the promise and the problems of this relatively new and rapidly developing approach. It should be compulsory reading for many LES practitioners.

Each section of the book contains a number of *exercises*, which typically invite the reader either to derive an expression that is quoted in the text or to generalize an analysis set out in the text. These exercises are often divided into several stages, and contain appropriate instructions, so that a diligent student will find his or her way through them. An advantage of the extensive use of appendices and student exercises is that analytical clarity and physical understanding are not obscured by unnecessary algebraic detail or by the need to review basic mathematical tools. The result is an exceptionally clear presentation, together with an often penetrating critique of both classical methods and recent developments in the theory and modelling of turbulent flows. There is excellent cross-referencing between one section and another, and an extensive and up-to-date bibliography.

I strongly recommend this book to advanced students of fluid mechanics, to their teachers and to all researchers, engineers and others with a professional interest in turbulent flows.

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