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REVIEWS

Fluid Vortices. Edited by S. I. GREEN. Kluwer, 1995. 878 pp. ISBN 0 79233 376 4. Dfl 495 or $320 or £199.

This is an unusual textbook because it is not the work of a single author but consists of nineteen separate articles, involving thirty-five authors. This is claimed to bring both breadth and depth to the treatment of vortex mechanics.

Since the book is aimed at graduate students, I have reviewed it with their needs in mind. I may say at the outset that I believe that established research workers will find the book very useful.

The first chapter by the editor himself expounds the basic principles of vortex mechanics. I believe it is not possible to do justice to a topic as subtle as vortex mechanics in the space the editor has allowed himself and he compounds his difficulty by spending time on marginal issues, such as the meaning of the term 'fluid vortices' or the physical meaning of the vorticity vector. The most useful part of the chapter is the description of specific flows such as the Rankine, Lamb and Burgers vortices. The author explains in a clear way the effect on the vorticity field of density variations and of stretching. His treatment of the vortex theorems is, in my view, too terse for students and he might have been wiser to refer the reader to a standard reference, such as Saffman (*Vortex Dynamics*, Cambridge University Press, 1992), for proofs. For example, the proof of Kelvin's circulation theorem is easier to follow if a Lagrangian parameterization of the material circuit is employed. Langrangian parameterization is important in computational vortex mechanics (see Chapter 15) but explaining it to students needs space.

Chapters 2, 3, 5 and 6 are devoted to large structures in mixing layers, jets, wakes and wall layers respectively. I found all four chapters very interesting. The chapter on wakes by Williamson is a model of what a contribution to a book like this should be. The author maintains scholarly objectivity without sacrificing the clarity of his exposition. The changes to the structure of the wake behind a circular cylinder as the Reynolds number is increased are lucidly described, helped by well-chosen photographs. Evidence and interpretation are separated and the reader is in a position to form his own view.

A contrasting approach is taken by Smith and Walker in their discussion of the turbulent wall layer. They present a plausible and well-argued interpretation of experiment and computation but no original data. This makes for a very readable account, which added to my own understanding, but one must have a slight reservation about such an approach in a graduate text. Of course, an excellent project for graduate students would be to read the literature themselves and try to fault the interpretation given.

The vortex ring is examined in Chapter 4 by Lim and Nickels. The formation of a vortex sheet at the lip of a circular pipe and its subsequent roll-up to form a vortex ring is the prototype for the process by which vortices are formed at sharp edges. These two processes as well as the subsequent response of the ring to viscous diffusion and its transition due to the Widnall instability receive a careful discussion, theory and experiment being compared where possible. The motion of two colliding vortex rings is discussed and the manner in which oblique collision leads to re-connection is illustrated by some excellent colour photographs – the standard of the visualizations presented in the book is high. Figure 4.5.2 depicting head-on collision represents some fascinating fluid mechanics.

Chapter 7 is devoted to an account by Bershader of compressibility effects. The effect on the structure of leading edge vortices is described, following Hall's work. The motion of rectilinear filaments interacting with a two-dimensional wing, whose span is parallel to the filament, is studied experimentally. Compressibility aids the visualization of the motion because of the concomitant density variations. The process is complex since secondary separation and shock formation can both occur.

Chapter 8 by Ash and Khorrami is concerned with the stability of rectilinear vortex filaments with swirl. Their account is clear and careful and gives enough details for the graduate student to work through the mathematics and to try to solve the resulting equations numerically. The important pioneering work of Lessen and of Howard and Gupta is fully described before an account of the asymptotic approach of Leibovich and Stewartson.

The material of Chapter 8 is relevant to the account of vortex breakdown given in Chapter 9 by Althaus, Brucker and Weimer. Unfortunately, these authors use different notations for the velocity components in cylindrical polars, which ought to have provoked editorial intervention. The authors describe recent computational work and compare it with experiment. Their approach is to follow numerically the evolution of the flow with a prescribed inlet axial flow and swirl and which is subject to an adverse pressure gradient at a prescribed radius. This pressure gradient must be adjusted to maintain the breakdown in the computational domain. A very clear description of bubble and of spiral breakdown is given and the transition between these states is described. However, the mechanism of transition is not known. This is just the sort of article to appeal to a good graduate student, who will see that much remains to be done in the field.

The first nine chapters are meant to deal with fundamental matters while the following ten chapters consider more specialized topics. I found all these chapters interesting and much of the material was new to me.

Chapter 10 is a lively and informative account by Green of the formation and properties of the tip vortex. The physics of both the initial formation and the appearance of strong axial flow is clearly presented and the experimental data on the core structure are described.

Chapter 11 by Waitz, Greitzer and Tan describes some intriguing vortex flows, including the interaction of a plane shock wave with a cylindrical inclusion of gas of different density. Baroclinic generation of vorticity takes place at the interface, a process familiar in GFD and bubble dynamics, but not in gasdynamics. A striking sequence of photographs illustrates the process in figure 11.6.3. The effect of the rolling up of the interface between two flowing and reacting gases is also described and will send the student back to Lesieur's chapter 2.

Chapter 12 by Blevins considers the interaction of vortex flows and structures. The wake of an oscillating cylinder is studied, so the student will revise chapter 5.

In chapter 15 Meiberg presents a useful account of numerical methods based on vortex dynamics for solving the incompressible Euler and Navier–Stokes equations. My only qualification is that there is no description of methods for two-dimensional or axisymmetric flows, such as the Krasny blob (which lead to the striking computations of the formation of a vortex ring by Nitsche and Krasny described in chapter 4) and contour dynamics. Although not any longer at the leading edge of research, these methods are still useful and are simple enough and fast enough on a modern work station for graduate students to code up and use.

The last three chapters are concerned with the effect of the low core pressure on multiphase flow. In particular, bubbles float towards the core (Chapter 18 by Chahine) while heavy particles are expelled (Chapter 19 by Crowe, Trout and Chung).

I think that the book will be useful to graduate students and its enthusiastic tone will attract them into the field. However, since the price of the book in the UK will be nearly £200, I suspect not many will buy it; a student edition would be welcome!

D. W. MOORE

Fluid Mechanics. By D. PNUELI and C. GUTFINGER. Cambridge University Press, 1993. 482 pp. £24.95.

The authors of this book state in its preface that it is intended as an introductory book for third year Mechanical Engineering students. These students are assumed to have the usual background '...mathematics, physics, engineering mechanics and thermodynamics'. The chapter headings are, in order: Introduction; Stress in a fluid; Fluid statics; Fluids in motion-integral analysis; Fluids in motion-differential analysis; Exact solutions of the Navier–Stokes equations; Energy equations; Similitude and order of magnitudes; Flows with negligible acceleration; High Reynolds number flows – regions from solid bodies; High Reynolds numbers – the boundary layer; Turbulent flow; Compressible flow; Non-Newtonian flow.

The material to be covered in each chapter is clearly explained in the initial paragraph. Following the discussion of each particular topic several worked examples are given.

The explanations of the several phenomena are generally well thought out and the illustrative examples are appropriate. There are numerous exercises for the student at the end of each chapter. The examples and students' exercises cover a wide range of material and, predictably, focus more on internal flows than external flows.

That being said, the book is flawed by numerous typographical errors (more in the worked examples than the text). Some of the figures in the examples are poorly executed and thus misleading.

Some educational theorists have written that the presence of typographical errors helps engage the student with the material, particularly if those errors are intentional and benign. This may be the case for a graduate student using this book as a text for review purposes. However, in the reviewer's experience of teaching students in an introductory course, more often than not misprints and typographical errors contribute to confusion rather than to engagement with the material.

In spite of its merits, I cannot recommend this book for use as a general purpose primary textbook in a first course in fluid mechanics.

E. C. COVERT