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REVIEWS

Hot-Wire Anemometry. By A. E. Perry. Clarendon, 1982. 184 pp. £20.00.
Principles and Practice of Laser-Doppler Anemometry, 2nd edn. By F. Durst, A. Melling and J. H. Whitelaw. Academic, 1981. 437 pp. £24.80.

These two books describe alternative ways of making velocity measurements in fluids. Each method has its own set of problems and a common aim of the books is to describe the source of the problems and to suggest, wherever possible, methods to overcome them. Both books are written by experts in their respective fields who have been active for a number of years.

Hot-wire Anemometry is concerned primarily with the fundamental principles of the hot-wire technique and numerous models describing hot-wire behaviour are examined in detail. A newcomer to the area might find the volume of analytical material daunting but a researcher with some knowledge of the subject should soon come to appreciate the merits of the book. A useful summary appears at the end of each chapter to assist the reader. Dr Perry has been working on this topic for many years and the book is based on his own experience and that of his many diligent and dedicated students.

Following the introduction, chapter 2 describes various models for analysing the behaviour of a hot-wire filament under steady and dynamic conditions. The operation of a constant-current hot-wire anemometer for the measurement of fluctuating velocities is explained in chapter 3. This leads on in the next chapter to the use of the constant-current technique for measuring temperature fluctuations. The use of the constant-temperature mode for the measurement of velocity and temperature fluctuations is the subject of chapters 5 and 6. Chapter 7 is devoted to a discussion of the interaction between the thermal and aeroelastic characteristics of hot-wire filaments and illustrates how inaccurate it can be to represent a hot wire by a rigid straight cylinder. The philosophy of hot-wire calibration is discussed in chapter 8, the longest and most interesting chapter in the book. Much emphasis is placed on the dynamic method of the calibration which has become the hallmark of the Melbourne school of hot-wire anemometry. The book concludes with the dramatically titled chapter 'The Ultimate Uncertainty'. The uncertainty is not related to the likely sales of the book but rather to the question of whether or not a hot wire faithfully responds to velocity fluctuations over a wide band of frequency.

Perry's book is an important contribution to hot-wire anemometry and I very much enjoyed reading it, but it is not without its faults. A number of minor typographical errors have slipped through and as a result some equations have inaccuracies in them. Apart from one example the book does not treat applications of hot-wire anemometry and the subjects of hot films and measurements in water are ignored. In recent years there have been advances in the use of split-film technology for making measurements in complex flow environments and in the use of aspirated hot-wire probes for measuring concentration, but these techniques are also excluded. The one application which is mentioned is the use of a flying hot wire to make measurements in the near wake of a bluff body. The reader will not need to be told where this work was carried out.

Principles and Practice of Laser-Doppler Anemometry is a well-established book in the field. The first edition was reviewed in this Journal 1977 (vol. 80, p. 204), and I do not propose to discuss it in detail here. The second edition is an update of those areas where there have been significant advances over the five years since the first edition. Some changes have been made to other sections to clarify the presentation. The book follows the format of a figure and detailed explanation on each page and this makes it easy to use as a reference book. The presentation is clear and efficient, but the narrative style is less interesting than that of Perry. Chapter 13, entitled 'Appraisal of laser-Doppler anemometry on the basis of recent measurements', has been extensively rewritten. Additional material has been included on photon correlation, particle sizing from Doppler signals and biasing introduced when averaging individual Doppler frequency measurements. About 140 references have been added in the second edition.

Hot-wire anemometry and laser-Doppler anemometry are complementary techniques, and it is unlikely that one will ever completely replace the other. In their various ways the two books reviewed here are excellent treatments of experimental techniques and should find a place side by side on the experimental fluid dynamicists' bookshelf.

P. W. BEARMAN

Compressible Flow. By STEFAN SCHREIER. Wiley, 1982. 577 pp. $44.50.

Good books on fluid mechanics occasionally rise above the nearly steady stream of texts, proceedings, and topical studies available to teachers and scholars. The flyleaf assures us that this is 'the first major new work in the field of compressible flow since 1972'. The reviewer will assess whether or not this is a good, major new work. The reader may have the task of identifying that previous milestone in compressible flow.

Professor Schreier teaches a one-year graduate course in compressible flow from which the present book has evolved. Ten chapters of text have 241 references through the year 1978, ten problems per chapter, and flow tables taken from earlier publications. A striking feature is the large number of equations given, 2065 in all. The way in which this happens will unfold as we proceed through the chapters.

Chapter 1, Basic Equations, gives the step-by-step derivation of the conservation relations: first for perfect fluids using the integral method and then for viscous fluids using the differential approach. The author gives special attention to a step-by-step derivation and a physical interpretation of each mathematical term. By the time the full Navier–Stokes equations appear, the student has a grasp of both their algebraic and their vector calculus representations. Some awkwardness about the nature of the second coefficient of viscosity arises in reconciling these two methods of derivation. One way around this issue is to draw upon the results of molecular gasdynamics where a second viscosity-like parameter appears quite naturally to account for the rotational relaxation time. The use of matrices for relating stresses to strain rates would also seem appropriate, but that level of mathematical preparation is not presumed.

Each of the seven subsequent chapters addresses a restricted class of flows, following traditional practices by aerodynamicists of eliminating a dimension or two in order that some analytical progress can be made. These seven chapters deal in turn with one-dimensional flow, two- and three-dimensional subsonic flow, two- and three-dimensional steady supersonic flow, unsteady one-dimensional flow, transonic flow, laminar and turbulent boundary layers. A consequence of this arrangement is that many of the basic concepts and principles in fluid mechanics are divorced from the chapter on basic equations and appear at various points throughout the book.

Thus, sound is in chapter 2, circulation in chapter 3, slipstreams in chapter 4. The classical theorems of Riemann, Kelvin and Helmholtz are omitted.

Chapter 2, Elementary One Dimensional Flow, develops Bernoulli's equation (neglecting gravity for gases), the concepts of streamtubes and streamlines, the speed of sound, the wind tunnel equations including normal shock waves, shock structure, and concludes with a section on the effects of heat addition and area change. The presentation is straightforward and easy to follow. Special formulas are given for quite a number of circumstances. This practice accounts for the very large number of different equations appearing in the book, making it a useful reference.

Potential flows, sub- and supersonic, are treated in chapters 3 and 4 respectively. Numerous approximate methods are given and the beginnings of numerical techniques appear. From here forward the practice of giving a step-by-step derivation is dropped in favour of citing references to prior works. Many approximate techniques are covered both for dealing with the flow equations in the physical plane and in the hodograph plane. The coverage of methods developed through the 1950s is remarkably broad (are these now 'classical'?) and some more recent techniques are added as well. Missing are the useful and elegant asymptotic matched expansions of Van Dyke and 'the method' of Chisnell–Chester–Whitham. This reviewer found the discussion of Mach or three-shock reflection cursory; a shame since that is such an intriguing challenge to theory.

The treatment in the next four chapters on transonic flow, laminar and turbulent boundary layers and real gas effects is done in very much the same spirit as just outlined; many methods, emphasis on classical works if one is permitted to extend that term through the 1950s, and the introduction of numerical solutions.

Real-gas effects, treated in chapter 9, present an author of a textbook with a cruel dilemma; to teach the subject requires using the results of statistical mechanics or at least some ingenious approximation such as Lighthill's characteristic temperatures and densities. Yet these require careful and detailed exposition lest the student be left with only a cursory and possibly misleading impression of the subject rather than a good working knowledge of it. The author has kept chapter 9 to 55 pages; some teachers would probably prefer to resort to Vincenti & Kruger's book.

Computational Methods, the final chapter, gives the book a strong and appropriate finish. The author presents the case for resort to numerical solution vs. analytical solution of approximately the real problem in a fair and balanced manner, with appropriate admonitions about the hazards of each. The field of 'computational fluid dynamics' is moving so rapidly that currency is unachievable in a general text. A second edition of this book would be very different for this reason alone. One wonders which of the old, approximate methods will become obsolete and which will endure as the foundations of extended computer-based solutions.

To sum up, this book should be welcomed as a text by teachers who have a sound background in compressible flow. They can give students a perspective and can fill in with verbal explanations a sense of what the fluid is doing. Otherwise, someone encountering this subject for the first time is likely to be overwhelmed by equations. As a reference for review on the other hand, the volume has a lot of information and therefore makes a good library item.

WAYLAND C. GRIFFITH

SHORTER NOTICES

Intense Atmospheric Vortices. Edited by L. BENGTSSON and J. LIGHTHILL. Springer, 1982. 326 pp. DM56.– (soft cover).

This volume forms part of the series 'Topics in Atmospheric and Oceanographic Sciences', and contains the proceedings of a symposium sponsored jointly by the International Union of Theoretical and Applied Mechanics and the International Union of Geodesy and Geophysics and held at Reading (UK) in July 1981. The aim of the symposium was to examine and understand the different mechanics for vorticity intensification that operate in two important types of meteorological phenomena, tropical cyclones and tornadoes. Approximately half the book is devoted to each topic. Most of the papers concentrate on discussing the physical mechanisms, on the basis of field observation, theoretical modelling, comprehensive numerical simulation or, in the case of tornadoes, laboratory model experiments. There are 24 papers in all, reproduced from the authors' camera-ready copy.

Stability of Thermodynamic Systems. Edited by J. CASAS-VÁZQUEZ and G. LEBON. Springer, 1982. 321 pp. DM 38.– (soft cover).

This is volume 164 in Springer's 'Lecture Notes in Physics' series, and contains the texts of twelve lectures presented at a course held at the Autonomous University of Barcelona in September 1981. Six of the lectures are on fluid-mechanical topics; four of these (by D. Jou, P. Bergé, M. Dubois and M. Zamora) are concerned primarily with Rayleigh–Bénard and other convective instabilities, one (by C. Pérez-García) is a general survey of hydrodynamic instabilities, and the other (by D. Quemada) concerns the shear-flow instability of concentrated suspensions. The final lecture (by C. Perelló) is a brief introduction to strange attractors. The book is reproduced from camera-ready copy.

Stability in the Mechanics of Continua. Edited by F. H. SCHROEDER. Springer, 1982. 412 pp. DM89.– (hardback).

This book contains the proceedings of the Second IUTAM Symposium with the same title, held at Nümbrecht, Germany, in 1981. The book is divided into two parts: 'Stability of Solid Continua and Mathematical Methods', containing 27 papers; and 'Stability of Fluid Continua', containing 11 papers. Of the latter, 6 concern curved flows (Taylor and Görtler vortices, etc.), 2 concern extensions of the Bénard problem, 2 concern boundary-layer instability, and one discusses the 'reduced molecular chaos' hypothesis for flow instability. The book is reproduced from camera-ready copy.

Mécanique Expérimentale des Fluides. Vol. II: Dynamique des Fluides Réels, Turbomachines, 3rd edn. By R. COMOLET. Masson, 1982. 453 pp. FF305.– (soft cover).

The first edition of both volumes of this wide-ranging engineering textbook were reviewed by Hunter Rouse in 1963 (*JFM* **17**, 318). The third edition of the first volume ('Statics and Dynamics of Inviscid Fluids') appeared in 1979. The passage of time has led the author to a comprehensive restructuring and rewriting: in 1963 Volume II contained ten chapters on viscous fluid mechanics and seven on turbomachinery, whereas now there are thirteen and one respectively. The chapter titles are: Introduction, Fundamental equations of fluid mechanics, Fluid statics, First integrals of fluid dynamics, Laminar flows, Turbulence and turbulent flows, Flow similarity (theory of scale models), Boundary layer theory (incompressible flow), Aerodynamics of geometrically simple bodies, Aerodynamics (cont.): aerofoils, Flow in pipes, Flow at singularities: discontinuous head loss, Flow in open channels, Elements of the theory of turbomachinery. The book is attractively laid out and written in French.

Engineering Meteorology. Edited by E. PLATE, Elsevier, 1982. 740 pp. $162.75.

The preface to this large and well-produced volume defines *Engineering Meteorology* as the field in which 'meteorological processes interact with engineering objectives'. Fundamental dynamical and physical atmospheric processes are presented in Part I (chapters 1–7) and engineering applications, particularly those involving hydrology, air pollution prediction and prevention and design loads on engineering structures are treated in Part II (chapters 8–15). More specifically the chapter headings and authors are as follows: Chapter 1, The atmosphere, by H. A. Panofsky; Chapter 2, Radiation and the radiation budget of the atmosphere, by K. Bullrich; Chapter 3, Cloud and precipitation physics and the water budget of the atmosphere, by H. R. Pruppacher; Chapter 4, Global climatology, by A. Baumgartner *et al.*; Chapter 5, Atmospheric turbulence, by N. O. Jensen and N. E. Busch; Chapter 6, Atmospheric boundary layers over homogeneous terrain, by S. P. Arya; Chapter 7, Atmospheric boundary layers over non-homogeneous terrain, by J. C. R. Hunt and J. E. Simpson; Chapter 8. Exchange processes at the earth–atmosphere interface, by W. Brutsaert; Chapter 9, Precipitation evaluation in hydrology, by J. F. Miller; Chapter 10, Turbulent diffusion: chimneys and cooling towers, by S. R. Hanna; Chapter 11, Turbulent diffusion near buildings, by R. N. Meroney; Chapter 12, The interaction of wind and structures, by A. G. Davenport; Chapter 13, Wind tunnel modelling of wind effects in engineering, by E. J. Plate; Chapter 14, Ice problems in engineering, by J. Schwarz; Chapter 15, Wind wave problems in engineering, by H. Mitsuyasu.

The volume will undoubtedly be a valuable reference for civil engineers involved in large scale design work in which meteorological considerations play a part. The very high price of the volume (well over £100!) will put it beyond the reach of most individuals, but the vast amount of useful information that it contains in well-edited form should make the volume an attractive purchase despite the price, for most libraries of civil engineering.

The Boundary Integral Equation Method for Porous Media Flow. By J. A. LIGGETT and P. L-F. LIU. Allen & Unwin, 1983. 255 pp. £20 (hardback).

This specialized text presents a computational technique for the solution of problems in porous media, with or without free surfaces. The technique involves the boundary-integral representation of solutions of Laplace's equation, and subsequent discretization of the potential over the surface of integration. The method has some computational advantages over finite-element methods (notably the effective reduction of three-dimensional problems to a two-dimensional grid) and it can be usefully combined with the finite-element method for problems with awkward geometry.

The method does not add greatly to the physical understanding of flow in porous media, and it is therefore unlikely to be useful for teaching purposes; it may however be useful to ground-water engineers, in providing a practical method (including full numerical program listings) for solving specific seepage problems.

Methods of Experimental Physics: vol. 18, Fluid Dynamics, Part A. Edited by R. J. EMRICH. Academic, 1981. 404 pp. $50.00 (hardback).

If you want to find out about flow-tracing particles, chronophotography, laser-Doppler velocimeters, Pitot probes, propeller, vane, hot-wire and hot-film anemometers, flowmeters, shadowgraph methods, schlieren systems, reference-beam interferometers, shearing interferometers, electron-beam flow visualization, and glow discharges, then this is the volume to consult. In short, an invaluable reference work, which should be to hand in every fluid-dynamics laboratory.

(Part B, also edited by R. J. Emrich, is concerned with measurement of density, temperature, pressure, composition and heat transfer, and includes chapters on light sources, apparatus, and dimensional analysis in fluid dynamics.)

Flow, its Measurement and Control in Science and Industry: vol. 2, 1981. Edited by WILLIAM W. DURGIN. Wiley, 1981. 867 pp. £45.75.

This turgid volume contains the proceedings of the Second International Symposium on Flow which was held in March 1981 in St Louis Missouri. It contains 84 papers reproduced photographically, under the headings Flow characteristics and fluid velocity measurement techniques; Fluid metering and control techniques; Flow measuring devices; Environmental flow measurement; Standards, traceability and facilities.

Flow Visualization II. Edited by W. MERZKIRCH. Hemisphere, 1982. 803 pp. $90.00.

This volume contains the proceedings of the Second International Symposium on Flow Visualization held in September 1980 in Bochum, West Germany. Like the previous volume, the reproduction of papers is photographic, but the work has been well edited, and the general scientific standard is high. The main headings are as follows: 1.1 Combustion, Furnace models (six papers); 1.2 Heat transfer, Heat exchangers (5 papers); 1.3 Fluid engines (9 papers); 1.4 Industrial problems (4 papers); 1.5 Pipe and channel flow (6 papers); 1.6 Flow separation (13 papers); 1.7 Wakes and vortices (10 papers); 1.8 Boundary layers (6 papers); 1.9 Supersonic flow and shock waves (6 papers); 1.10 Stratified flow and oceanography (6 papers); 1.11 Multiphase flow (10 papers); 1.12 Rheology (4 papers); 1.13 Medical problems (4 papers); 2.1 Surface flow (9 papers); 2.2 Tracers (7 papers); 2.3 Optical methods (6 papers); 2.4 Instrumentation (4 papers).

The emphasis being on flow-visualization techniques, many of the papers contain photographs, and the quality of reproduction of these appears also to be excellent. This will also be a valuable reference volume for laboratories of fluid mechanics.

Evaporation into the Atmosphere. By W. H. BRUTSAERT. Reidel, 1981. 340 pp. $34.95.

This book aims to present a general view of studies of evaporation in the natural environment, and to bring together some of the different ways it is studied by different specialists. It does not cover evaporation in industrial processes. It is based on lecture courses given to students (in USA and Europe) of civil and environmental engineering and agriculture. The book begins with broad perspectives of the world climate and of the history of interest in the subject. It continues with the basic ideas and models of water vapour in the lower atmosphere and makes use of more recent understanding of turbulence and diffusion in the atmosphere boundary layer, including inhomogeneous conditions. The final part of the book describes currently available techniques for measuring and calculating the rate of evaporation, with reference to the principles of the first part of the book. It is a well-produced book. Its bibliography contains about 500 references.

Industrial Heat Exchangers: a basic guide. By G. WALKER. Hemisphere, 1982. 408 pp. $41.50.

This book is not really for most *JFM* readers. It is 'for buyers and users of heat exchangers and for young engineers, who, having taken a college course on heat transfer, find that they still know little about heat exchangers'. However, this very practical book does show that, even in such topologically complex flows as heat exchangers, many of the basic principles described in much simpler flows work surprisingly well to guide the engineer. There are chapters on various designs of heat exchanger (including regenerative heat exchangers), the mechanical design factors, degradation of performance due to corrosion and fouling, buying a heat exchanger, codes and standards, and computer analysis of heat exchangers.

Engineering Fluid Mechanics (with separate Solution manual). By A. MIRONER. McGraw Hill, 1979. 592 pp. £28.50 (cloth), £7.50 (paperback).

This is a textbook for undergraduate engineering students taking their first and part of their second course in fluid mechanics. It is a long book but reasonably priced. It contains most of what one expects of such textbooks and more in the form of a cautionary chapter on an introduction to the use of the digital computer, which engineering students would do well to *read*, as well as to look at the diagrams of the amazing flows that can be computed! There are chapters at the end on turbomachinery, open channel flow and compressible flow.

Unsteady Turbulent Shear Flows. Edited by R. MICHEL, J. COUSTEIX and R. HOUDEVILLE. Springer, 1981, 424 pp. $39.00.

This book is the proceedings of an IUTAM Symposium held in Toulouse in May 1981. It was high time such a conference was held and these proceedings will be found useful by all those interested in turbulent flows which are also unsteady on a timescale much larger than that of the typical turbulent eddies. The book was produced within a year of the conference being held – a fine achievement. Three review lectures were given, including an extensive and useful review by L. W. Carr of the various techniques for producing unsteady flows in wind tunnels. The subjects of the papers include not only turbulent shear layers (in boundary layers, pipe flow, jets, etc.) but also the flow over oscillating aerofoils, vortex shedding, separation off steps, and turbulence in reciprocating engines. One hopes that the rather brief accounts of research given in these papers are soon published more fully in journals.