Analytical Fluid Dynamics

George Emanuel, CRC Press, Boca Raton, 1994, 424 pp., $66.95

This book is intended for serious graduate study in accordance with the traditional association of fluid dynamics with applied mathematics. While the title could be applied to a broad range of subjects, the author has chosen to emphasize selected topics in depth rather than attempt a less detailed coverage of the entire field. The result is a thorough exposition of many important achievements in analytical fluid mechanics in the recent decades, including the author's own contributions, with valuable references and comments on the underlying historical evolution of the discipline. The book is divided into four parts, followed by eight appendices, hints and solutions to problems, and references.

Part I, Basic Concepts (four chapters), presents a mathematically uncompromising discussion of the fundamental concepts (Eulerian and Lagrangian formulations, stress and deformation rate tensors, constitutive relations, and Reynolds' transport theorem), followed by an equally thorough coverage of the conservation equations, the second law of thermodynamics, and kinematics.

In Part II, Inviscid Flow, Chapters 5, 6, and 7 are devoted to Euler equations, shock wave dynamics, and the hodograph transformation, respectively. The reviewer would have appreciated this thorough exposition and tabulation of the normal and tangential derivatives in the flow behind general two-dimensional and axisymmetric shock waves (in Chapter 6 and appendices) at a time of need 35 years ago! Chapter 8 is based primarily the work of the author and his collaborators on rotational solutions of the compressible Euler equations by application of the substitution principle.

Part III, Exact Solutions for a Viscous Flow, contains four chapters on coordinate systems and similarity, Rayleigh flow, Couette flow, and stagnation point flow. Again, the coverage is general, including the effects of compressibility and heat conduction, and the classical examples are discussed in the broader context. The detailed presentation of the differential operators and conservation equations in curvilinear coordinates (Chapter 9 and appendices) is especially valuable reference information.

Part IV, Laminar Boundary-Layer Theory for Steady Two-Dimensional or Axisymmetric Flow, constitutes approximately one-third of the book and clearly reflects the author's personal, longtime dedication to this area of fluid dynamics. The six chapters of Part IV cover incompressible flow over a flat plate, flow at high Reynolds number, incompressible boundary-layer theory, compressible boundary-layer theory, supersonic boundary-layer examples, and second-order boundary-layer theory. Thus, the presentation proceeds in a logical manner from the classical Blasius solution in Chapter 13 and the use of body-oriented coordinates in Chapter 15 to Chapter 16, which discusses thoroughly the similarity transformations for two-dimensional and axisymmetric compressible boundary layers (including detailed tables of numerical solutions derived from the contributions of the author and his coworkers). Methods for nonsimilar boundary layers are also presented. Chapter 17 contains a discussion of supersonic thin airfoil theory in preparation for practical examples of boundary-layer calculations. In the belief that the understanding of the role of the boundary-layer concept as part of the complete flowfield is of paramount importance in all branches of fluid dynamics (analytical, computational, and experimental), the reviewer particularly appreciates the discussion of matched asymptotic expansions for large Reynolds numbers in Chapter 14 and the coverage of higher-order approximations in Chapter 18.

As intended, this book is best suited for use in graduate courses and as a source of background information on research in analytical and computational methods. It is indeed a unique reference monograph of lasting value for practitioners of fluid dynamics.

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Fluid Vortices

Sheldon I. Green (ed.), Kluwer Academic Publishers, Dordrecht, The Netherlands, 1995, 912 pp., $ 320.00

Part of a series of books on subjects in which fluid mechanics plays a fundamental role, this volume is presented as an advanced, graduate-level textbook covering all salient flows in which vortices play a significant role. It consists of 19 chapters written by different well-known authors, the first 9 chapters covering fundamental aspects of vortex flows (mixing layer vortices, vortex rings, wake vortices, vortex stability, etc.), and the remaining 10 chapters covering industrial and environmental vortex flows (which include aeropropulsion system vortices and some other applications of potential interest to an aeronautical or astronautical scientist) and multiphase vortex flows (free-surface effects, cavitation, interactions with bubbles and particles, etc.). The suggested suitability of the book for a two-term sequence of courses is questionable, as the level of the book is probably generally too high; it is not written in the consistent style and level of a text, there are no problems, etc., nor are there likely to be schools teaching courses specifically on vortex flows. On the other hand, this reviewer knows of no book, certainly no recent book, that so comprehensively and authoritatively covers all aspects of vortex flows, from the fundamentals to state-of-the-art research topics. It would serve magnificantly as the centerpiece of an advanced seminar or study group and can lay claim to space on any technical bookshelf or library as the best available "snapshot," as of the mid-90's, of research areas and applications, where vortices and vorticity play a dominant or major role.

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