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BOOK REVIEW

Inviscid Incompressible Flow. By J. S. MARSHALL. Wiley Interscience, 2001. 392 pp. ISBN 0 471 37566 7. £73.50 or $104.80.

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The vast majority of first courses in fluid dynamics deal primarily with inviscid, incompressible flows, as such a simplification allows the introduction of important nonlinear aspects of fluid motion at its fundamental level. Whereas there are many excellent classical books on the subject, teachers and students would welcome one comprehensive book containing a detailed and thoughtful treatment of fundamentals, computational methods and solutions to real-world problems involving complex boundaries and reference material for professionals.

Inviscid Incompressible Flow is a carefully constructed book with sections emphasizing different aspects of fluid dynamics. It begins in Chapter 1 with the discussion of the role of viscosity in high-Reynolds-number flow using simple scaling arguments and outlining the relevance of the inviscid fluids to real-life problems. The elements of vector and tensor analysis together with vector and integral identities that are used later in the text are presented in Chapter 2. In Chapters 3–5 the author considers viscous and compressible fluids to introduce properties, basic principles and a few simple solutions to the full Navier–Stokes equation. It is extremely satisfying to see the accuracy and rigour with which these foundations are laid. Starting with the conservation laws of mechanics, the basic laws are typically formulated in both integral and differential form with careful and rigorous mathematical derivations to follow. To overcome the restriction on smoothness of velocity and density used in the derivations of basic laws, the dynamics of the flow across discontinuous surfaces is studied in detail in Chapter 5. In Chapters 6–8 several general theorems governing the evolution of velocity, vorticity and pressure fields are derived. My only criticism of the treatment of the material in these chapters is a lack of examples and illustrations of the applicability of these theorems to fluid dynamical problems. As a result the idea of why one needs these derivations, apart from the fundamental conservation laws, may not be apparent to students. The analytical solution techniques for two-dimensional potential flows based on complex variable theory are discussed in Chapter 9 and the calculations of forces acting on a body immersed in such flows presented in Chapter 10. Chapter 12 deals with the corresponding solution methods for three-dimensional flows. The treatment of the fundamentals in these three chapters is exemplary: the formulation of the problem is preceded by a concise statement of mathematical preliminaries and followed by a short illustrative example.

One of the strongest parts of Marshall's book is the detailed discussion of vortex dynamics in Chapter 11 (for two-dimensional flows), Chapter 13 (axisymmetric vortex dynamics) and Chapter 14 (thin-core vortex tubes). This emphasis can in part be explained by author's own research interests. Much attention is paid to the computational methods used to elucidate the dynamics of vortices, as these methods are the only tools that can be used to study the dynamics of many interacting vortices. Six useful subroutines for the calculation of vortex dynamics can be found on the accompanying Internet site of the Iowa Institute of Hydraulic Research.

In comparison with the detailed and impressive treatment of vortex dynamics the last two chapters devoted to wave propagation (Chapter 15) and stability (Chapter 16) are somewhat disappointing, since these topic are not covered at a similar level. Also, some discussion of more recent topics in the fluid dynamics of inviscid incompressible flows, like the formation of singularities, topological fluid dynamics, turbulence, etc., could be helpful to guide graduate students and researchers.

Each chapter contains a set of carefully selected theoretical problems, but hints and solutions to the problems at the end of the book would enhance the usefulness of these problems to students. Four chapters also contain well-devised computational projects, which provide a valuable tool for more computationally oriented courses.

Overall the book makes an excellent textbook for introductory course in fluid dynamics. It combines rigour and readability as it systematically presents the fundamentals and applications of fluid dynamics.

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