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BOOK REVIEWS

Internal Flow – Concepts and Applications. By E. M. Greitzer, C. S. Tan & M. B. Graf. Cambridge University Press, 2004. 707 pp. ISBN 0 521 34393 3. £70.00.
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The motion of gases and liquids inside enclosures or fluid devices is characterized as internal flow while the motion over bodies is usually referred as external flow. There are several, although not many, books focusing on the fluid mechanical aspects of external flows which are appropriate for classroom instruction at the graduate level. The present book on internal flows appears to be the first of its kind, focusing on applications exclusively from the field of general turbomachinery. The authors have drawn on their extensive experience with internal flows in an industrial environment and in teaching the topic to engineers and students. They have selected applications specifically from propulsion systems such as jet engines, fluid machinery such as compressors, turbines and pumps and duct flows including nozzles, diffusers and combustion chambers.

The three authors have collected material and information that is dispersed in the technical literature, and compiled and integrated it in a coherent treatment for use by students in the classroom or by professional engineers. More specifically, the intended audience appears to be graduate students in mechanical, aerospace or chemical engineering, and perhaps also in physics, plus researchers entering the field of fluid mechanics of internal flows, particularly turbomachinery. The strength of the book is its well-crafted balance between the fundamental concepts involved in the phenomena, which are mainly presented through mathematical descriptions, and examples from technological applications that are used to illuminate the theoretical principles. The authors show that even for complex processes such as those involved in turbomachinery one can learn a great deal about their behaviour from a clear understanding and through rigorous use of basic principles. In that context, this book will transform readers' views and perceptions that internal flows in turbomachinery are classified as applied science where strong emphasis on fundamentals is of secondary importance.

Internal flows exhibit a plethora of fluid mechanical phenomena, one being the formation and presence of several types of vortices. In that respect the concepts of vorticity and circulation are given particular attention in this book and they are treated extensively. Chapter 3, consisting of 65 pages on vorticity and circulation, serves as a framework for the physical interpretation and qualitative understanding of the fluid phenomena involved in the flows under consideration, particularly in three-dimensional and/or unsteady flows. These fundamental ideas are used extensively to describe phenomena related to flows in rotating passages and swirling flows in Chapters 7 and 8, respectively. The generation of streamwise vorticity and flow three-dimensionality (secondary flows) are treated in depth in the 60-page Chapter 9.

The integral and differential forms of the equations of motion are introduced in Chapter 1 by using tensor notation algebra. The authors, however, have preferred to use the vector form of the equations in all subsequent chapters. Chapter 4 provides a brief and rather selective account of laminar and turbulent bounded and free shear layer flows and Chapter 5 describes the sources of energy losses in the context of entropy changes. Unsteady flow phenomena, including free shear layer instabilities, waves and oscillations are described in Chapter 6. Compressible internal flows are discussed in Chapter 10 mostly through quasi-one-dimensional equations of motion. Issues related to heat addition, which is one of the key processes in combustion phenomena associated with propulsive devices and turbomachinery, are discussed in Chapter 11. Among flow cases analysed are heat addition in swirling flows, viscous flow mixing with heat addition, lobed mixer nozzles and ejectors. Last, Chapter 12 includes a description of modelling two- and three-dimensional non-uniformities in selected flows through screens, diffusing passages, upstream influence of strut-vanes, self-excited propagating disturbances in compressors and axial compressor instability.

The text is well-written; the concepts are discussed and presented with reasonable clarity and vigour in a compact manner and the illustrations are, in most cases, of high quality. There are very few typographical errors, mostly names in the list of references. A drawback for students using this book is that there are no problems for solution and only one chapter has a summary at the end.

For all of us who like to use the notion of vorticity for understanding viscous flow phenomena, this book is a refreshing experience; while the distinct perspective that the authors bring to the subject will be appreciated by all readers. Despite the minor drawbacks mentioned above, the book is a must for all graduate students and will appeal to researchers entering the field of turbomachinery. It will serve well students on courses where the subject is taught. The book, due to its clear presentation of fundamentals and the key examples from applications, may also be of instructional value to students on general fluid mechanics courses.

Yiannis Andreopoulos

Viscous Incompressible Flow for Low Reynolds Numbers. By M. Kohr & I. Pop. WIT Press, 2004. 208 pp. ISBN 1 85312 991 7. £148.00 or $237.00 or 222.00.

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The aim of the authors in writing this monograph is stated as a contribution to the theory of low Reynolds number fluid mechanics, which brings to the attention of interested researchers the state of the art of this theory. I think that the aim of the authors has been largely achieved and this book deserves a place on bookshelves alongside *Low Reynolds Number Hydrodynamics* by J. Happel & H. Brenner (Prentice-Hall, 1965). The layout of the chapters provides ready accessibility by the research worker for reference purposes. Each chapter has at its end a list of references which have been cited within that chapter, but it would have been additionally helpful if *all* references cited throughout the book could have been grouped together alphabetically in a comprehensive list. The level of the bulk of the material covered is intended for research workers in the field, but some material could form the basis of an undergraduate or taught master's degree course.

An introductory chapter establishes the equations governing linearized flow at low Reynolds number and provides the underpinning theory: uniqueness theorems and the Lorentz reciprocal theorem for both steady and unsteady Stokes flow together with Greens identity for Oseen flow. In chapter 2, results are then developed relating to the theory and applications of the basic singularity method for flows involving solid or liquid particles. Generalized fundamental solutions of the Stokes and Oseen equations are also presented together with some exact solutions. The singularity method is used to derive the solutions for Stokes flows involving a sphere in motion in the presence of a solid plane wall. This chapter also has a very useful catalogue of the fundamental and higher-order singularity solutions for Stokes flow, including Stokeslet, rotlet, stresslet, Stokeslet doublet and Stokeslet quadrupole. Some fundamental solutions are presented for Stokes flows involving spherical solid or liquid particles as well as the translating spheroid. Results using optimal singularity representations for a Stokes flow past a stationary or moving sphere in the presence of a plane wall reveal the degree of accuracy which can be attained solely with first-order singularity approximations.

Chapter 3 develops the theory of hydrodynamic potentials for Stokes flow involving the motion of solid particles or liquid drops, and then proceeds to the basis of the core material of the subsequent book, namely the representations of the velocity and pressure fields in Stokes flow expressed in terms of the integrated boundary values of velocity and traction. Existence and uniqueness results are also presented as well as generalized Faxén laws for the force and torque acting on a particle with applications to a solid spherical or prolate spheroidal particle. Faxén's law for the total force on a spherical liquid drop is also addressed. In this chapter, the authors provide the theory of steady Stokes systems and a discussion of the hydrodynamic double layer potential and its jump across a Lyapunov surface. Boundary integral representations for the velocity and pressure fields of unsteady Stokes flows in bounded and unbounded domains are also studied. Chapter 4 develops the boundary integral method for steady and unsteady Stokes flows and provides a catalogue of classical and more recent results, while in chapter 5, the authors address some problems involving Stokes flows with interfaces.

This book provides a readily accessible reference monograph to both research workers already familiar with boundary element techniques and those who would like to learn about the methodology. The latter part of the book is heavily weighted towards theory rather than applications other than the classical. Also, there is no mention of the numerous applications that have been made to constructing streamlines of flows, especially those for truly three-dimensional flows, when the boundary integral method has led to some remarkable results.

M. E. O'Neill

SHORT NOTICE

Annual Review of Fluid Mechanics, vol. 37. By J. L. Lumley, S. H. Davis & P. Moin. Annual Reviews, 2005. 517 pp. ISBN 0 8243 0737 2. Institutions: $179.00 (print only or online only) or $215 USA, $220 Foreign (print plus online). Individuals: $79 USA, $84 Foreign (print plus online).

This is a list of the chapter titles and authors for the current volume of this periodical.

Robert T. Jones. One of a Kind, W. G. Vincenti

George Gabriel Stokes on Water Wave Theory, A. D. D. Craik

Microcirculation and Hemorheology, A S Popel and P. C. Johnson

Bladerow Interactions. Transition and High-lift Aerofoils in Low-pressure turbines, H. P. Hodson and R. J. Howell