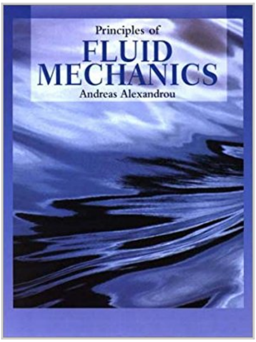

Principles of Fluid Mechanics

By Andreas N. Alexandrou

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This book provides a comprehensive and wide-ranging introduction to fluid mechanics, assuming only a basic knowledge of calculus and physics. Introduces fluid mechanics within the context of a broad range of topics and disciplines by combining elements and concepts from different disciplines as is often found in solutions to engineering problems. The book integrates a discussion of fluid flow phenomena with that of other subjects, such as Solid Mechanics, Heat Transfer, Thermodynamics, and others. It also includes discussions of other fields of specialization often used to solve engineering problems, such as chemistry, biology, economics, sociology, and others. And, it integrates the use of computers and modern experimental techniques. The first edition of *Introduction to Fluid Mechanics* provides a unique thematic organization and divides the material into three sections: **Theory.** This section is divided into four categories: Introduction, Conservation Laws, Fluid Kinematics, and Fluid Dynamics. **Analysis.** In this section, procedures such as Dimensionless Analysis, Analytics, Experimental and Numerical Solutions are introduced and applied to fundamental problems. **Special Topics.** Topics such as ideal, invisicid flow, compressible flow, and dynamics of rotating fluids are reserved for separate chapters. The book also introduces ideas from computational and experimental fluid mechanics. An essential reference for all engineering professionals.

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Principles of Fluid Mechanics By Andreas N. Alexandrou Bibliography

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Editorial Review

From the Inside Flap
Preface

This textbook is an introduction to fluid dynamics. The first nine chapters form the basis for the first sophomore level course in fluid dynamics. In addition, Chapters 4, 5, 6, 8, 9, 10, 11, 12, and 13 form the basis for a second course in fluid dynamics. The main prerequisite for the book is a basic knowledge of calculus and physics.

Physical phenomena, and by extension fluid flow, are governed by the same basic laws. Therefore, particular topics can be deduced from the more general framework provided by the laws of nature. For this reason, whenever possible the material in this textbook is presented from a general, deductive viewpoint. This approach is also consistent with the needs of modern engineering analysis and design, and is achieved without sacrificing the quality or quantity of the discussion of "classical" fluid flow phenomena.

Traditionally, students consider fluid dynamics to be a difficult topic because of its mathematical nature and the apparent complexity of its concepts. Often, whether in class or textbooks, the material is presented as a collection of seemingly unrelated concepts, thus making it more difficult for students to fully comprehend the material. Here, the material is organized in a manner that avoids this confusion; similar themes are grouped and discussed together.

Some of the unique features of this book include (a) the point of view of the presentation, (b) the thematic organization of the material, and (c) the introduction of ideas from computational and experimental fluid dynamics. The material and concepts are demonstrated and reinforced through examples and problems for each section and chapter.

Since most concepts in fluid dynamics are quite mathematical, one of the appendixes reviews the basic mathematics required for the study of fluid dynamics. In my experience, this chapter prepares students for the more mathematically rigorous parts of the material.

The book is divided into three parts: Theory

The material in this part is divided into the following categories: (a) introduction, (b) conservation laws (c) fluid kinematics, and (d) fluid dynamics (for finite and differential control volumes). Since the material is presented from a general point of view, in which the universality of the laws of nature is stressed, Hydrostatics is not discussed in a separate chapter but is presented as a special case of the momentum equation in Chapter 2.

Irrespective of the driving forces or dynamic conditions that induce flow, the motion and deformation of fluid particles are characterized by simple kinematic principles. Therefore, in Chapter 4, fluid flow is defined using purely kinematic arguments without reference to the dynamic effects.

Following the kinematics of fluid flow, Chapter 5 introduces and emphasizes the governing laws and constitutive relations. The concept of the constitutive behavior of fluids and therefore of the viscosity of fluids follows naturally from the discussion. Concepts such as laminar flow, turbulent flow, and non-Newtonian fluids are also presented within this framework. An entirely new section on boundary conditions completes the theoretical description of fluid systems. Analysis

Following the theoretical and mathematical description of fluid systems, this part deals with the analysis of fluid problems. This step is also consistent with engineering design methodology. In Chapters 6, 7, and 8 and in Chapters 12 and 13, various solution procedures such as dimensionless analysis, analytic, experimental, and numerical solutions are introduced and applied to fundamental problems. Traditional concepts such as internal and external flows are presented in a separate chapter under a common theme dealing with the use of combined analytical and experimental methods in fluid dynamics. Special Topics

Finally, special topics such as ideal, inviscid flow, compressible flow, and dynamics of rotating fluids are reserved for separate chapters. This avoids unnecessary confusion about the relation of these topics to the fundamental theory of fluid dynamics. Instructors can select, at will, the topics to cover in their course.

I would like to express my thanks to my colleagues Nikos Gatsonis, David Olinger, Hamid Johari, Jim Hermanson, and David Watt, who have helped me in the preparation of this manuscript by providing not only advice and encouragement, but also original problems and pictures from their work. Particular mention is reserved for Mark Richman, whose unfailing intuition and keen mathematical insight have helped me throughout the writing of the manuscript. I would also like to thank Nadeem Majaj and Professor Marios Soteriou for providing problems, and Lisa Majaj for her editing prior to submission of the manuscript.

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From the Back Cover

A DEDUCTIVE APPROACH TO FLUID MECHANICS

By following a concise thematic organization, **Principles of Fluid Mechanics** covers the basic theory, physics, and applications of fluid flow from a general viewpoint that makes it easy for students to follow and understand.

- Introduces fluid mechanic concepts using the universality—and simplicity—of the conservation laws
- Covers the material in a deductive manner by following a systematic, step-by-step approach
- Reinforces the discussion and concepts through numerous example problems
- Stresses the combined use of mathematical analysis and experimental and computer modeling in solving problems
- Promotes an overall educational approach required by current engineering problems that are open-ended and multidisciplinary in nature

About the Author

ANDREAS ALEXANDROU is currently a Professor of Mechanical Engineering at Worcester Polytechnic Institute and Director of the Semisolid Metal Processing Center. He received the B.S. degree in Mechanical Engineering (1982) from the American University of Beirut while on a U.S. AID/Fullbright scholarship. At the University of Michigan he earned the M.S. degrees in Mechanical Engineering (1983) and Civil Engineering (1985), and the Ph.D. degree in Mechanical Engineering (1986). His research interests and contributions are in basic fluid flows, fluid mechanic applications in material processing, and microgravity and wake flows. He has well over 70 scientific publications and numerous presentations to his credit, and has co-authored an advanced textbook on viscous fluid flow. He received the 1992 WPI Board of Trustee's Award for Outstanding Teaching, the 1993 Morgan Distinguished Instructorship Award, and the 1996 Russell M. Searle Teacher of the Year Award in Mechanical Engineering.

Users Review

From reader reviews:

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