

## Chapter 6 • Viscous Flow in Ducts

**P6.1** An engineer claims that flow of SAE 30W oil, at 20°C, through a 5-cm-diameter smooth pipe at 1 million N/h, is laminar. Do you agree? A million newtons is a lot, so this sounds like an awfully high flow rate.

**Solution:** For SAE 30W oil at 20°C (Table A.3), take  $\rho = 891 \text{ kg/m}^3$  and  $\mu = 0.29 \text{ kg/m-s}$ . Convert the weight flow rate to volume flow rate in SI units:

$$Q = \frac{\dot{w}}{\rho g} = \frac{(1\text{E}6 \text{ N/h})(1/3600 \text{ h/s})}{(891 \text{ kg/m}^3)(9.81 \text{ m/s}^2)} = 0.0318 \frac{\text{m}^3}{\text{s}} = \frac{\pi}{4} (0.05 \text{ m})^2 V, \text{ solve } V = 16.2 \frac{\text{m}}{\text{s}}$$

$$\text{Calculate } Re_D = \frac{\rho V D}{\mu} = \frac{(891 \text{ kg/m}^3)(16.2 \text{ m/s})(0.05 \text{ m})}{0.29 \text{ kg/m-s}} = 2500 \text{ (transitional)}$$

This is not high, but **not** laminar. *Ans.* With careful inlet design, low disturbances, and a very smooth wall, it might still be laminar, but **No**, this is *transitional*, not definitely laminar.

**P6.2** The present pumping rate of North Slope crude oil through the Alaska Pipeline (see the chapter-opener photo) is about 600,000 barrels per day (1 barrel = 42 U.S. gallons). What would be the maximum rate if the flow were constrained to be *laminar*? Assume that Alaskan crude oil fits Fig. A.1 of the Appendix at 60°C.

**Solution:** From Fig. A.1 for crude at 60°C,  $\rho = 0.86(1000) = 860 \text{ kg/m}^3$  and  $\mu = 0.0040 \text{ kg/m-s}$ . From Eq. (6.2), the maximum laminar Reynolds number is about 2300. Convert the pipe diameter from 48 inches to 1.22 m. Solve for velocity:

$$Re_D = 2300 = \frac{\rho V D}{\mu} = \frac{(860 \text{ kg/m}^3) V (1.22 \text{ m})}{0.0040 \text{ kg/m-s}}; \text{ Solve for } V = 0.00877 \frac{\text{m}}{\text{s}}$$

$$Q = VA = (0.00877 \text{ m/s})(\pi/4)(1.22 \text{ m})^2 = 0.01025 \text{ m}^3/\text{s} \times 3600 \times 24 =$$

$$= 886 \text{ m}^3/\text{day} \approx \mathbf{5600 \text{ barrels/day} \text{ } Ans.}$$

# Introduction To Fluid Mechanics 7th Solution Manual

**John I. Hochstein, Andrew L. Gerhart**



## **Introduction To Fluid Mechanics 7th Solution Manual:**

A Brief Introduction to Fluid Mechanics Donald F. Young, Bruce R. Munson, Theodore H. Okiishi, Wade W. Huebsch, 2010-12-21 A Brief Introduction to Fluid Mechanics 5th Edition is designed to cover the standard topics in a basic fluid mechanics course in a streamlined manner that meets the learning needs of today's student better than the dense encyclopedic manner of traditional texts This approach helps students connect the math and theory to the physical world and practical applications and apply these connections to solving problems The text lucidly presents basic analysis techniques and addresses practical concerns and applications such as pipe flow open channel flow flow measurement and drag and lift It offers a strong visual approach with photos illustrations and videos included in the text examples and homework problems to emphasize the practical application of fluid mechanics principles

**Young, Munson and Okiishi's A Brief Introduction to Fluid Mechanics** John I. Hochstein, Andrew L. Gerhart, 2021-01-13 This book is designed to cover the standard topics in a basic fluid mechanics course in a streamlined manner that meets the learning needs of students better than the dense encyclopedic format of traditional texts This approach helps students connect math and theory to the physical world and apply these connections to solving problems The text lucidly presents basic analysis techniques and addresses practical concerns and applications such as pipe flow open channel flow flow measurement and drag and lift It offers a strong visual approach with photos illustrations and videos included in the text examples and homework problems to emphasize the practical application of fluid mechanics principles

Introduction to Fluid Mechanics James E. A. John, William L. Haberman, 1988

**EBOOK: Fluid Mechanics Fundamentals and Applications (SI units)** Yunus Cengel, John Cimbala, 2013-10-16 Fluid Mechanics Fundamentals and Applications is written for the first fluid mechanics course for undergraduate engineering students with sufficient material for a two course sequence This Third Edition in SI Units has the same objectives and goals as previous editions Communicates directly with tomorrow's engineers in a simple yet precise manner Covers the basic principles and equations of fluid mechanics in the context of numerous and diverse real world engineering examples and applications Helps students develop an intuitive understanding of fluid mechanics by emphasizing the physical underpinning of processes and by utilizing numerous informative figures photographs and other visual aids to reinforce the basic concepts Encourages creative thinking interest and enthusiasm for fluid mechanics New to this edition All figures and photographs are enhanced by a full color treatment New photographs for conveying practical real life applications of materials have been added throughout the book New Application Spotlights have been added to the end of selected chapters to introduce industrial applications and exciting research projects being conducted by leaders in the field about material presented in the chapter New sections on Biofluids have been added to Chapters 8 and 9 Addition of Fundamentals of Engineering FE exam type problems to help students prepare for Professional Engineering exams

**Fundamental Principles of Heat Transfer** Stephen Whitaker, 2013-10-22 Fundamental Principles of Heat Transfer

introduces the fundamental concepts of heat transfer conduction convection and radiation It presents theoretical developments and example and design problems and illustrates the practical applications of fundamental principles The chapters in this book cover various topics such as one dimensional and transient heat conduction energy and turbulent transport forced convection thermal radiation and radiant energy exchange There are example problems and solutions at the end of every chapter dealing with design problems This book is a valuable introductory course in heat transfer for engineering students **Applied Mechanics Reviews** ,1948 **Fundamentals of Fluid Mechanics** Philip M. Gerhart,Richard J. Gross,John I. Hochstein,1992 **GAS DYNAMICS, Seventh Edition** RATHAKRISHNAN, E.,2020-07-01 This revised and updated seventh edition continues to provide the most accessible and readable approach to the study of all the vital topics and issues associated with gas dynamic processes At every stage the physics governing the process its applications and limitations are discussed in detail With a strong emphasis on the basic concepts and problem solving skills this text is suitable for a course on Gas Dynamics Compressible Flows High speed Aerodynamics at both undergraduate and postgraduate levels in aerospace engineering mechanical engineering chemical engineering and applied physics The elegant and concise style of the book along with illustrations and worked out examples makes it eminently suitable for self study by students and also for scientists and engineers working in the field of gas dynamics in industries and research laboratories The computer program to calculate the coordinates of contoured nozzle with the method of characteristics has been given in C language The program listing along with a sample output is given in the Appendix NEW TO THE EDITION A new chapter on the Power of Compressible Bernoulli Equation Extra chapter end examples in Chapter 5 Additional exercise problems in Chapters 5 6 7 and 8 KEY FEATURES Concise coverage of the thermodynamic concepts to serve as a revision of the background material Introduction to measurements in compressible flows and optical flow visualization techniques Introduction to rarefied gas dynamics and high temperature gas dynamics Solutions Manual for instructors containing the complete worked out solutions to chapter end problems In depth presentation of potential equations for compressible flows similarity rule and two dimensional compressible flows Logical and systematic treatment of fundamental aspects of gas dynamics waves in the supersonic regime and gas dynamic processes TARGET AUDIENCE BE B Tech Mechanical Engineering Aeronautical Engineering ME M Tech Thermal Engineering Aeronautical Engineering Fluid Mechanics for Civil and Environmental Engineers Ahlam I. Shalaby,2018-02-21 An ideal textbook for civil and environmental mechanical and chemical engineers taking the required Introduction to Fluid Mechanics course Fluid Mechanics for Civil and Environmental Engineers offers clear guidance and builds a firm real world foundation using practical examples and problem sets Each chapter begins with a statement of objectives and includes practical examples to relate the theory to real world engineering design challenges The author places special emphasis on topics that are included in the Fundamentals of Engineering exam and make the book more accessible by highlighting keywords and important concepts including Mathcad

algorithms and providing chapter summaries of important concepts and equations      *Solutions Manual for Introduction to Fluid Mechanics* Robert W. Fox, Alan T. McDonald, 1985      **Subject Guide to Books in Print**, 2001      Catalog of Copyright Entries. Third Series Library of Congress. Copyright Office, 1971      **Solutions Manual for Introduction to Fluid Mechanics** William S. Janna, 1987      Student Solutions Manual to accompany A Brief Introduction to Fluid Mechanics, 5e Donald F. Young, Bruce R. Munson, Theodore H. Okiishi, Wade W. Huebsch, 2011-03-15 This is the Student Solutions Manual to accompany A Brief Introduction to Fluid Mechanics 5th Edition A Brief Introduction to Fluid Mechanics 5th Edition is designed to cover the standard topics in a basic fluid mechanics course in a streamlined manner that meets the learning needs of today's student better than the dense encyclopedic manner of traditional texts This approach helps students connect the math and theory to the physical world and practical applications and apply these connections to solving problems The text lucidly presents basic analysis techniques and addresses practical concerns and applications such as pipe flow open channel flow flow measurement and drag and lift It offers a strong visual approach with photos illustrations and videos included in the text examples and homework problems to emphasize the practical application of fluid mechanics principles      *The Finite Element Method in Engineering* Singiresu S. Rao, 2017-10-31 The Finite Element Method in Engineering Sixth Edition provides a thorough grounding in the mathematical principles behind the Finite Element Analysis technique an analytical engineering tool originated in the 1960's by the aerospace and nuclear power industries to find usable approximate solutions to problems with many complex variables Rao shows how to set up finite element solutions in civil mechanical and aerospace engineering applications The new edition features updated real world examples from MATLAB Ansys and Abaqus and a new chapter on additional FEM topics including extended FEM X FEM Professional engineers will benefit from the introduction to the many useful applications of finite element analysis Includes revised and updated chapters on MATLAB Ansys and Abaqus Offers a new chapter Additional Topics in Finite Element Method Includes discussion of practical considerations errors and pitfalls in FEM singularity elements Features a brief presentation of recent developments in FEM including extended FEM X FEM augmented FEM A FEM and partition of unity FEM POUFEM Features improved pedagogy including the addition of more design oriented and practical examples and problems Covers real life applications sample review questions at the end of most chapters and updated references      Books in Print Supplement, 2002      **Scientific and Technical Aerospace Reports**, 1987      **Munson, Young and Okiishi's Fundamentals of Fluid Mechanics** Philip M. Gerhart, Andrew L. Gerhart, John I. Hochstein, 2016-09-13 NOTE The Binder ready Loose leaf version of this text contains the same content as the Bound Paperback version Fundamentals of Fluid Mechanics 8th Edition offers comprehensive topical coverage with varied examples and problems application of visual component of fluid mechanics and strong focus on effective learning The text enables the gradual development of confidence in problem solving The authors have designed their presentation to enable the gradual development of reader confidence in problem solving Each

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