

# Gas Dynamics 2nd Edition

Fundamentals of Gas Dynamics John Wiley & Sons

Aerodynamics is a science engaged in the investigation of the motion of air and other gases and their interaction with bodies, and is one of the most important bases of the aeronautic and astronautic techniques. The continuous improvement of the configurations of the airplanes and the space vehicles aid the constant enhancement of their performances are closely related with the development of the aerodynamics. In the design of new flying vehicles the aerodynamics will play more and more important role. The undertakings of aeronautics and astronautics in our country have gained achievements of world interest, the aerodynamics community has made outstanding contributions for the development of these undertakings and the science of aerodynamics. To promote further the development of the aerodynamics, meet the challenge in the new century, summary the experience, cultivate the professional personnel and to serve better the cause of aeronautics and astronautics and the national economy, the present Series of Modern Aerodynamics is organized and published.

An Introduction to Compressible Flow is a concise, yet comprehensive treatment of one-dimensional compressible flow designed to provide mechanical and aerospace engineering students with the background they need for aerodynamics and turbomachinery courses. This book covers isentropic flow, normal shock waves, oblique shock waves, and Prandtl-Meyer flow and their applications. The first chapter reviews the physics of air, control volume analysis and provides a review of thermodynamics. Most textbooks provide very concise treatments of compressible flow- this text will supplement that material, which is often too concise to provide students with the background they need. This book also supports practicing engineers who have never developed a mastery of issues related to one-dimensional compressible flow or who need to review this material at some point in their careers. The appendices provide the tables and charts commonly associated with this material. One new addition is an oblique shock table, which tabulates the oblique shock angle for the weak shock solution as a function of Mach number and deflection angle. The book includes examples of problem solutions, and each chapter has a list of problems to enable students to apply their understanding.

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)

Gas Dynamics 2Nd Ed.

An Introduction

Hypersonic and High Temperature Gas Dynamics

Computational Fluid Dynamics: Principles and Applications

**The second edition of Analytical Fluid Dynamics presents an expanded and updated treatment of inviscid and laminar viscous compressible flows from a theoretical viewpoint. It emphasizes basic assumptions, the physical aspects of flow, and the appropriate formulations of the governing equations for subsequent analytical treatment. Topics covered inc**

**New edition of the popular textbook, comprehensively updated throughout and now includes a new dedicated website for gas dynamic calculations The thoroughly revised and updated third edition of Fundamentals of Gas Dynamics maintains the focus on gas flows below hypersonic. This targeted approach provides a cohesive and rigorous examination of most practical engineering problems in this gas dynamics flow regime. The conventional one-dimensional flow approach together with the role of temperature-entropy diagrams are highlighted throughout. The authors—noted experts in the field—include a modern computational aid, illustrative charts and tables, and myriad examples of varying degrees of difficulty to aid in the understanding of the material presented. The updated edition of Fundamentals of Gas Dynamics includes new sections on the shock tube, the aerospike nozzle, and the gas dynamic laser. The book contains all equations, tables, and charts necessary to work the problems and exercises in each chapter. This book’s accessible but rigorous style: Offers a comprehensively updated edition that includes new problems and examples Covers fundamentals of gas flows targeting those below hypersonic Presents the one-dimensional flow approach and highlights the role of temperature-entropy diagrams Contains new sections that examine the shock tube, the aerospike nozzle, the gas dynamic laser, and an expanded coverage of rocket propulsion Explores applications of gas dynamics to aircraft and rocket engines Includes behavioral objectives, summaries, and check tests to aid with learning Written for students in mechanical and aerospace engineering and professionals and researchers in the field,**

**the third edition of Fundamentals of Gas Dynamics has been updated to include recent developments in the field and retains all its learning aids. The calculator for gas dynamics calculations is available at <https://www.oscarbilarz.com/gascalculator> gas dynamics calculations**

**Multi-phase flows are part of our natural environment such as tornadoes, typhoons, air and water pollution and volcanic activities as well as part of industrial technology such as power plants, combustion engines, propulsion systems, or chemical and biological industry. The industrial use of multi-phase systems requires analytical and numerical strategies for predicting their behavior. In its third extended edition this book contains theory, methods and practical experience for describing complex transient multi-phase processes in arbitrary geometrical configurations. This book provides a systematic presentation of the theory and practice of numerical multi-phase fluid dynamics. In the present second volume the mechanical and thermal interactions in multiphase dynamics are provided. This third edition includes various updates, extensions, improvements and corrections. A revised edition to applied gas dynamics with exclusive coverage on jets and additional sets of problems and examples**

**The revised and updated second edition of Applied Gas Dynamics offers an authoritative guide to the science of gas dynamics. Written by a noted expert on the topic, the text contains a comprehensive review of the topic; from a definition of the subject, to the three essential processes of this science: the isentropic process, shock and expansion process, and Fanno and Rayleigh flows. In this revised edition, there are additional worked examples that highlight many concepts, including moving shocks, and a section on critical Mach number is included that helps to illuminate the concept. The second edition also contains new exercise problems with the answers added. In addition, the information on ram jets is expanded with helpful worked examples. It explores the entire spectrum of the ram jet theory and includes a set of exercise problems to aid in the understanding of the theory presented. This important text: Includes a wealth of new solved examples that describe the features involved in the design of gas dynamic devices Contains a chapter on jets; this is the first textbook material available on high-speed jets Offers comprehensive and simultaneous coverage of both the theory and application Includes additional information designed to help with an understanding of the material covered Written for graduate students and advanced undergraduates in aerospace engineering and mechanical engineering, Applied Gas Dynamics, Second Edition expands on the original edition to include not only the basic information on the science of gas dynamics but also contains information on high-speed**

**jets.**

**Handbook of Fluid Dynamics, Second Edition**

**Fundamentals of Gas Dynamics**

**Foundations of Gas Dynamics**

**Computational Fluid Mechanics and Heat Transfer, Second Edition**

Fluid mechanics embraces engineering, science, and medicine. This book's logical organization begins with an introductory chapter summarizing the history of fluid mechanics and then moves on to the essential mathematics and physics needed to understand and work in fluid mechanics. Analytical treatments are based on the Navier-Stokes equations. The book also fully addresses the numerical and experimental methods applied to flows. This text is specifically written to meet the needs of students in engineering and science. Overall, readers get a sound introduction to fluid mechanics.

An introduction to CFD fundamentals and using commercial CFD software to solve engineering problems, designed for the wide variety of engineering students new to CFD, and for practicing engineers learning CFD for the first time. Combining an appropriate level of mathematical background, worked examples, computer screen shots, and step by step processes, this book walks the reader through modeling and computing, as well as interpreting CFD results. The first book in the field aimed at CFD users rather than developers. New to this edition: A more comprehensive coverage of CFD techniques including discretisation via finite element and spectral element as well as finite difference and finite volume methods and multigrid method. Coverage of different approaches to CFD grid generation in order to closely match how CFD meshing is being used in industry. Additional coverage of high-pressure fluid dynamics and meshless approach to provide a broader overview of the application areas where CFD can be used. 20% new content

This text provides an introduction to gas turbine engines and jet propulsion for aerospace or mechanical engineers. The text is divided into four parts: introduction to aircraft propulsion; basic concepts and one-dimensional/gas dynamics; parametric (design point) and performance (off-design) analysis of air breathing propulsion systems; and analysis and design of major gas turbine engine components (fans, compressors, turbines, inlets, nozzles, main burners, and afterburners). Design concepts are introduced early (aircraft performance in introductory chapter) and integrated throughout. Written with extensive student input on the design of the book, the book builds upon definitions and gradually develops the thermodynamics, gas dynamics, and gas turbine engine principles.

This book provides professionals in the field of fluid dynamics with a comprehensive guide and resource. It balances three traditional areas of fluid mechanics - theoretical, computational, and experimental - and expounds on basic science and engineering techniques. Each chapter introduces a topic, discusses the primary issues related to this subject, outlines approaches taken by experts, and supplies references for further information. The text enables experts in particular areas to become familiar with useful information from outside their specialization, providing a broad reference for the significant areas within fluid dynamics.

Essential Computational Fluid Dynamics

Vehicle Dynamics and Control

Mechanics of Liquids and Gases

Elements of Gas Turbine Propulsion

Computational Fluid Dynamics: A Practical Approach, Third Edition, is an introduction to CFD fundamentals and commercial CFD software to solve engineering problems. The book is designed for a wide variety of engineering students new to CFD, and for practicing engineers learning CFD for the first time. Combining an appropriate level of mathematical background, worked examples, computer screen shots, and step-by-step processes, this book walks the reader through modeling and computing, as well as interpreting CFD results. This new edition has been updated throughout, with new content and improved figures, examples and problems. Includes a new chapter on practical guidelines for mesh generation Provides full coverage of high-pressure fluid dynamics and the meshless approach to provide a broader overview of the application areas where CFD can be used Includes online resources with a new bonus chapter featuring detailed case studies and the latest developments in CFD

Course of Theoretical Physics, Volume 6: Fluid Mechanics discusses several areas of concerns regarding fluid mechanics. The book provides a discussion on the phenomenon in fluid mechanics and their intercorrelations, such as heat transfer, diffusion in fluids, acoustics, theory of combustion, dynamics of superfluids, and relativistic fluid dynamics. The text will be of great interest to researchers whose work involves or concerns fluid mechanics.

Handbook of Fluid Dynamics offers balanced coverage of the three traditional areas of fluid dynamics-theoretical, computational, and experimental-complete with valuable appendices presenting the mathematics of fluid dynamics, tables of dimensionless numbers, and tables of the properties of gases and vapors. Each chapter introduces a different fluid

This book is a self-contained text for those students and readers interested in learning hypersonic flow and high-temperature gas dynamics. It assumes no prior familiarity with either subject on the part of the reader. If you have never studied hypersonic and/or high-temperature gas dynamics before, and if you have never worked extensively in the area, then this book is for you. On the other hand, if you have worked and/or are working in these areas, and you want a cohesive presentation of the fundamentals, a development of important theory and techniques, a discussion of the salient results with emphasis on the physical aspects, and a presentation of modern thinking in these areas, then this book is also for you. In other words, this book is designed for two roles: 1) as an effective classroom text that can be used with ease by the instructor, and understood with ease by the student; and 2) as a viable, professional working tool for engineers, scientists, and managers who have any contact in their jobs with hypersonic and/or high-temperature flow.

Computational Fluid Dynamics

GAS DYNAMICS, Seventh Edition

International Series of Monographs in Natural Philosophy

Fundamentals, Simulations and Micro Flows

International Series of Monographs in Natural Philosophy, Volume 3, Interstellar Gas Dynamics focuses on the progress on research on the motion of gases in interstellar space and stellar atmospheres, including issues on cosmical gas dynamics and magnetohydrodynamics. The publication first offers information

on the distribution, motion, and physical state of the interstellar gas. Topics include composition of the interstellar medium; cloud structure of the interstellar gas; spiral structure and distribution of the interstellar gas; ionization of the interstellar hydrogen; temperature of the interstellar gas; interaction between the interstellar gas and magnetic fields; and relativistic particles in an interstellar space. The book also takes a look at the discontinuities in the motion of the interstellar gas, as well as the fundamental theory of shock waves, ionization fronts, shock waves with light emission, and hydromagnetic discontinuities. The manuscript examines the equations of motion of the interstellar gas, including hydromagnetic equations of motion, one-dimensional motions and similarity solutions, motion of ionization fronts, and interstellar turbulence. The publication is a dependable reference for readers interested in interstellar gas dynamics. Provides a clear, concise, and self-contained introduction to Computational Fluid Dynamics (CFD) This comprehensively updated new edition covers the fundamental concepts and main methods of modern Computational Fluid Dynamics (CFD). With expert guidance and a wealth of useful techniques, the book offers a clear, concise, and accessible account of the essentials needed to perform and interpret a CFD analysis. The new edition adds a plethora of new information on such topics as the techniques of interpolation, finite volume discretization on unstructured grids, projection methods, and RANS turbulence modeling. The book has been thoroughly edited to improve clarity and to reflect the recent changes in the practice of CFD. It also features a large number of new end-of-chapter problems. All the attractive features that have contributed to the success of the first edition are retained by this version. The book remains an indispensable guide, which: Introduces CFD to students and working professionals in the areas of practical applications, such as mechanical, civil, chemical, biomedical, or environmental engineering Focuses on the needs of someone who wants to apply existing CFD software and understand how it works, rather than develop new codes Covers all the essential topics, from the basics of discretization to turbulence modeling and uncertainty analysis Discusses complex issues using simple worked examples and reinforces learning with problems Is accompanied by a website hosting lecture presentations and a solution manual Essential Computational Fluid Dynamics, Second Edition is an ideal textbook for senior undergraduate and graduate students taking their first course on CFD. It is also a useful reference for engineers and scientists working with CFD applications.

Mechanics of Liquids and Gases, Second Edition is a 10-chapter text that covers significant revisions concerning the dynamics of an ideal gas, a viscous liquid and a viscous gas. After an expanded introduction to the fundamental properties and methods of the mechanics of fluids, this edition goes on dealing with the kinetics and general questions of dynamics. The next chapters describe the one-dimensional pipe flow of a gas with friction, the elementary theory of the shock tube; Riemann's theory of the wave propagation of finite intensity, and the theory of plane subsonic and supersonic flows. Other chapters consider the elements of the theory of three-dimensional subsonic and supersonic flows past bodies; the fluctuating laminar flow in a uniform pipe of circular cross-section; the

hydrodynamic theory of lubrication; the variational principle of Helmholtz; and the theory of plane and axisymmetric laminar jets. The remaining chapters look into the semi-empirical theories of turbulence and their application in the analysis of axisymmetric jets, with and without swirl, and in the calculation of the resistance of rough plates. These chapters also discuss the dynamics of a viscous gas and the elements of the theory of laminar and turbulent boundary layers at high speeds. This book will be of value to mechanical engineers, physicists, and researchers.

A class-tested primer for students, scientists and engineers who would like to have a basic understanding of the physics and the behaviour of high-temperature gases. It is a valuable tool for astrophysicists as well. The first chapters treat the basic principles of quantum and statistical mechanics and how to derive thermophysical properties from them. Special topics are included that are rarely found in other textbooks, such as the thermophysical and transport properties of multi-temperature gases and a novel method to compute radiative transfer.

Gasdynamics, Theory and Applications

Thermo-fluid Dynamics of Two-Phase Flow

Analytical Fluid Dynamics

Gas Dynamics

This textbook provides a clear and concise introduction to both theory and application fluid dynamics, suitable for all undergraduates coming to the subject for the first time. It has a wide scope, with frequent references to experiments, and numerous exercises illustrating the main ideas.

This second edition of a highly regarded text covers all the recent research developments in gas dynamics including the direct simulation Monte Carlo method (DSMC).

Foundations of Gas Dynamics covers supersonic and subsonic flow phenomena where compressibility of the fluid cannot be ignored. It finds application in jet and rocket propulsion systems as well as handling industrial gas flow at high speeds. Students and engineers in the mechanical, aerospace, and chemical disciplines will find it useful. It begins with basic concepts such as isentropic flows, shock, and supersonic expansion in one dimension. These are followed by one-dimensional flows with friction and heat exchange. Two-dimensional theory with small perturbations is presented, with its applications illustrated by supersonic airfoils. Method of characteristics is used for flow with two independent variables, either with two spatial coordinates or with time variation in one dimension. In later chapters, acoustic wave propagation, supersonic flow combustion, and unsteady shock formation are treated thoroughly. The book ends with a chapter on basic hypersonic flow, with a discussion of similarity rules.

Computational Fluid Dynamics (CFD) is an important design tool in engineering and also a substantial research tool in various physical sciences as well as in biology. The objective of this book is to provide university students with a solid foundation for understanding numerical methods employed in today's CFD and to familiarise them with modern CFD codes by hands-on experience. It is also intended for engineers and scientists starting work in the field of CFD or for those who apply CFD codes. Due to the detailed index, the text can serve as a reference handbook too. Each chapter includes an extensive bibliography, which provides an excellent basis for further studies.

High Temperature Gas Dynamics

Multiphase Flow Dynamics 2

Handbook of Fluid Dynamics

Interstellar Gas Dynamics

A comprehensive examination of the fundamentals of compressible flow and gas dynamics.

This textbook on Fundamentals of Gas Dynamics will help students with a background in mechanical and/or aerospace engineering and practicing engineers working in the areas of aerospace propulsion and gas dynamics by providing a rigorous examination of most practical engineering problems. The book focuses both on the basics and more complex topics such as quasi one dimensional flows, oblique shock waves, Prandtl Meyer flow, flow of steam through nozzles, etc. End of chapter problems, solved illustrations and exercise problems are presented throughout the book to augment learning. ^

This comprehensive text provides basic fundamentals of computational theory and computational methods. The book is divided into two parts. The first part covers material fundamental to the understanding and application of finite-difference methods. The second part illustrates the use of such methods in solving different types of complex problems encountered in fluid mechanics and heat transfer. The book is replete with worked examples and problems provided at the end of each chapter.

Partial Differential Equations presents a balanced and comprehensive introduction to the concepts and techniques required to solve problems containing unknown functions of multiple variables. While focusing on the three most classical partial differential equations (PDEs)—the wave, heat, and Laplace equations—this detailed text also presents a broad practical perspective that merges mathematical concepts with real-world application in diverse areas including molecular structure, photon and electron interactions, radiation of electromagnetic waves, vibrations of a solid, and many more. Rigorous pedagogical tools aid in student comprehension; advanced topics are introduced frequently, with minimal technical jargon, and a wealth of exercises reinforce vital skills and invite additional self-study. Topics are presented in a logical progression, with major concepts such as wave propagation, heat and diffusion, electrostatics, and quantum mechanics placed in contexts familiar to students of various fields in science and engineering. By understanding the properties and applications of PDEs, students will be equipped to better analyze and interpret central processes of the natural world.

Applied Gas Dynamics

An Introduction to the Theory of Fluid Flows

International Series of Monographs in Aeronautics and Astronautics:

Division II: Aerodynamics

Elementary Fluid Dynamics

*This textbook provides students studying thermodynamics for the first time with an accessible and readable primer on the subject. The book is written in three parts: Part I covers the fundamentals of thermodynamics, Part II is on gas dynamics, and Part III focuses on combustion. Chapters are written clearly and concisely and include examples and problems to support the concepts outlined in the text. The book begins with a discussion of the fundamentals of thermodynamics and includes a thorough analysis of engineering devices. The book moves on to address applications in gas dynamics and combustion to include advanced topics such as two-phase critical flow and blast theory. Written for use in Introduction to Thermodynamics, Advanced Thermodynamics, and Introduction to Combustion courses, this book uniquely covers thermodynamics, gas dynamics, and combustion in a clear and concise manner, showing the integral connections at an advanced undergraduate or graduate student level.*

*Provides all necessary equations, tables, and charts as well as self tests. Included chapters cover reaction propulsion systems and real gas effects. Written and organized in a manner that makes it accessible for self learning.*

*Vehicle Dynamics and Control provides a comprehensive coverage of vehicle control systems and the dynamic models used in the development of these control systems. The control system applications covered in the book include cruise control, adaptive cruise control, ABS, automated lane keeping, automated highway systems, yaw stability control, engine control, passive, active and semi-active suspensions, tire-road friction coefficient estimation, rollover prevention, and hybrid electric vehicles. In developing the dynamic model for each application, an effort is made to both keep the model simple enough for control system design but at the same time rich enough to capture the essential features of the dynamics. A special effort has been made to explain the several different tire models commonly used in literature and to interpret them physically. In the second edition of the book, chapters on roll dynamics, rollover prevention and hybrid electric vehicles have been added, and the chapter on electronic stability control has been enhanced. The use of feedback control systems on automobiles is growing rapidly. This book is intended to serve as a useful resource to researchers who work on the development of such control systems, both in the automotive industry and at universities. The book can also serve as a textbook for a graduate level course on Vehicle Dynamics and Control.*

*This book is the second edition of a successful, self-contained text for those students and readers interested in learning hypersonic flow and high-temperature gas dynamics. Like the first edition, it assumes no prior familiarity with either subject on the part of the reader. If you have never studied hypersonic and/or high-temperature gas dynamics before, and if you have never worked extensively in the area, then this book is for you. On the other hand, if you have worked and/or are working in these areas, and you want a cohesive presentation of the fundamentals, a development of important theory and techniques, a discussion of the salient results with emphasis on the physical aspects, and a presentation of*

*modern thinking in these areas, then this book is also for you. In other words, this book is designed for two roles: (1) as an effective classroom text that can be used with ease by the instructor, and understood with ease by the student; and (2) as a viable, professional working tool for engineers, scientists, and managers who have any contact in their jobs with hypersonic and/or high-temperature flow. Because of its success, most of the first edition has been carried over to the second edition with the addition of much new material. This second edition has updated figures and data to complement the presentation and discussion of the fundamentals. New to this edition are some educational tools that the author has found successful in previous books: (1) previews of each chapter written in plain language to inform the reader why it is important to read and understand the material in the chapter, to highlight the important aspects, and to whip up the readers interest; (2) design examples scattered throughout the book to illustrate the applic*

*Rarefied Gas Dynamics*

*Thermodynamics, Gas Dynamics, and Combustion*

*Molecular Gas Dynamics and the Direct Simulation of Gas Flows*

*Fluid Mechanics*

This book has been written for graduate students, scientists and engineers who need in-depth theoretical foundations to solve two-phase problems in various technological systems. Based on extensive research experiences focused on the fundamental physics of two-phase flow, the authors present the detailed theoretical foundation of multi-phase flow thermo-fluid dynamics as they apply to a variety of scenarios, including nuclear reactor transient and accident analysis, energy systems, power generation systems and even space propulsion.

Fluid mechanics, the study of how fluids behave and interact under various forces and in various applied situations-whether in the liquid or gaseous state or both-is introduced and comprehensively covered in this widely adopted text. Revised and updated by Dr. David Dowling, Fluid Mechanics, Fifth Edition is suitable for both a first or second course in fluid mechanics at the graduate or advanced undergraduate level. The leading advanced general text on fluid mechanics, Fluid Mechanics, 5e includes a free copy of the DVD "Multimedia Fluid Mechanics," second edition. With the inclusion of the DVD, students can gain additional insight about fluid flows through nearly 1,000 fluids video clips, can conduct flow simulations in any of more than 20 virtual labs and simulations, and can view dozens of other new interactive demonstrations and animations, thereby enhancing their fluid mechanics learning experience. Text has been reorganized to provide a better flow from topic to topic and to consolidate portions that belong together. Changes made to the book's pedagogy accommodate the needs of students who have completed minimal prior study of fluid mechanics. More than 200 new or revised end-of-chapter problems illustrate fluid mechanical principles and draw on phenomena that can be observed in everyday life. Includes free Multimedia Fluid Mechanics 2e DVD

Fundamentals of Gas Dynamics, Second Edition is a comprehensively updated new edition and now includes a chapter on the gas dynamics of steam. It covers the fundamental concepts and governing equations of different flows, and includes end of

chapter exercises based on the practical applications. A number of useful tables on the thermodynamic properties of steam are also included. Fundamentals of Gas Dynamics, Second Edition begins with an introduction to compressible and incompressible flows before covering the fundamentals of one dimensional flows and normal shock waves. Flows with heat addition and friction are then covered, and quasi one dimensional flows and oblique shock waves are discussed. Finally the prandtl meyer flow and the flow of steam through nozzles are considered.

Partial Differential Equations

Hypersonic and High-temperature Gas Dynamics

An Introduction to Compressible Flow