Hypersonic And High Temperature Gas Dynamics Second Edition Aiaa Education

The airplane has experienced phenomenal advancement in the twentieth century, changing at an exponential rate from the Wright brothers to the present day. In this ground breaking work based on new research, Dr John D. Anderson, Jr, a curator at the National Air and Space Museum, analyzes the historical development of the conceptual design process of the airplane. He aims to answer the question of whether airplane advancement has been driven by a parallel advancement in the intellectual methodology of conceptual airplane design. In doing so, Anderson identifies and examines six case histories of 'grand designers' in this field, and challenges some of the preconceived notions of how the intellectual methodology of conceptual airplane design advanced. Filled with over one hundred illustrations which bring his words to life, Anderson unfolds the lives and thoughts of these grand designers.
The High Temperature Aspects of Hypersonic Flow is a record of the proceedings of the AGARD-NATO Specialists' Meeting, held at the Technical Centre for Experimental Aerodynamics, Rhode-Saint-Genese, Belgium in April 1962. The book contains the papers presented during the meeting that tackled a broad range of topics in the aspects of hypersonic flow. The subjects covered during the meeting include pressure measurements, interference effects, the use of wind tunnels in aircraft development testing, high temperature gas characteristics, boundary layer research, stability and control and the use of rocket vehicles in flight research. Aerospace engineers and aeronautical engineers will find the book invaluable.

Kinetic Processes in Gases and Plasmas provides a survey of studies on transport and chemical kinetic processes in high temperature gases and plasmas. The book is concerned with conditions produced by the interaction of an object with the atmosphere at hypersonic velocities. The text also provides a foundation for the flow field equations which include chemical reactions and other transport processes, and to present in some detail the microscopic considerations underlying these calculations. Chapters are devoted to the discussion of topics such as the molecular theory of transport equations; transport processes in ionized gases; and inelastic energy transfer processes and chemical kinetics. Aerospace engineers, physicists, chemists, and astrophysicists will find the book a good reference material.

The National Aerospace Initiative (NAI) was conceived as a joint effort between the Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA) to sustain the aerospace leadership of the United States through the acceleration of selected aerospace technologies: hypersonic flight, access to space, and space technologies. The Air Force became concerned about the NAIâ€™s possible consequences on Air Force programs and budget if NAI program decisions differed from Air Force priorities. To examine this issue, it asked the NRC for an independent review of the NAI. This report presents the results of that assessment. It focuses on three questions asked by the Air Force: is NAI technically feasible in the time frame laid out; is it financially feasible over that period; and is it operationally relevant.

Designed for advanced undergraduate and graduate courses in modern boundary-layer theory, this frequently cited work offers a self-contained treatment of theories for treating laminar and turbulent boundary layers of reacting gas mixtures. 1962 edition.

Describes the interaction between the fluid flow and the high temperature phenomena experienced in the hypersonic regime. Presents the principles of aerothermodynamics in nonequilibrium hypersonic flow regimes, covering theory, application and surface phenomena. Chapters 1 to 5 explain how to develop computational fluid dynamics (CFD) techniques for computing nonequilibrium, chemically reacting flows in the hypersonic regime. Chapters 6 to 8 examine the important physical phenomena that occur in hypersonic flows. The final chapter is devoted to the nonequilibrium kinetics at solid surfaces, which is useful in addressing the problems of the nonequilibrium gas-surface interactions that arise in hypersonic flight.
Unified, self-contained view of nonequilibrium effects, body geometries, and similitudes available in hypersonic flow and thin shock layer; appropriate for graduate-level courses in hypersonic flow theory. 1966 edition.
Winner of the Summerfield Book Award. The next great leap for jet propulsion will be to power-sustained, efficient flight through the atmosphere.
Molecular Physics and Hypersonic Flows bridges the gap between the fluid dynamics and molecular physics communities, emphasizing the role played by elementary processes in hypersonic flows. In particular, the work is primarily dedicated to filling the gap between microscopic and macroscopic treatments of the source terms to be inserted in the fluid dynamics codes. The first part of the book describes the molecular dynamics of elementary processes both in the gas phase and in the interaction with surfaces by using quantum mechanical and phenomenological approaches. A second group of contributions describes thermodynamics and transport properties of air components, with special attention to the transport of internal energy. A series of papers is devoted to the experimental and theoretical

study of the flow of partially ionized gases. Subsequent contributions treat modern computational techniques for 3-D hypersonic flow. Non-equilibrium vibrational kinetics are then described, together with the coupling of vibration-dissociation processes as they affect hypersonic flows. Special emphasis is given to the interfacing of non-equilibrium models with computational fluid dynamics methods. Finally, the last part of the book deals with the application of direct Monte Carlo methods in describing rarefied flows.

Based on more than 10 years of teaching intermediate dynamics at the Air Force Institute of Technology, this book is suitable as a text for a graduate-level or advanced undergraduate-level course in 3-dimensional dynamics, or as a reference. The methods and techniques presented have been tested in the classroom, and have facilitated several research projects undertaken by the author. The basics of vector mathematics in three-dimensional space is introduced in the first chapter, and is facilitated by a vector notation that encourages a thorough understanding of kinematic and dynamic variables. Subsequent chapters cover particle kinematics, particle dynamics, rigid body kinematics, and rigid body dynamics using the framework of Newtonian mechanics. Energy and variational approaches, including Hamilton's Law of Varying Action, Hamilton's Principle, and Lagrange's Equation are introduced in Chapter 6. Each chapter includes solved problems, which demonstrate the concepts covered in the chapter, as well as additional problems that may be used as practice problems or as homework assignments.

Anderson's book provides the most accessible approach to compressible flow for Mechanical and Aerospace Engineering students. In keeping with previous versions, the 3rd edition uses numerous historical vignettes that show the evolution of the field.New pedagogical features--"Roadmaps" showing the development of a given topic, and "Design Boxes" giving examples of design decisions--will make the 3rd edition even more student-friendly than before.The 3rd edition strikes a careful balance between classical methods of determining compressible flow, and modern numerical and computer techniques (such as CFD) now used in industry & research.A new Book Website will contain all problem solutions for instructors, and extended information on CFD.

Progress in Astronautics and Rocketry, Volume 7: Hypersonic Flow Research compiles papers presented at a conference on hypersonics held at the Massachusetts Institute of Technology in August 1961. This book discusses the low Reynolds number effects, chemical kinetics effects, inviscid flow calculations, and experimental techniques relating to the problems in acquiring an understanding of hypersonic flow. The structure and composition of hypersonic wakes with attendant complex chemical kinetic effects is only briefly mentioned. This text consists of five parts. Parts A to C comprise of theoretical papers on the problems of calculating flow fields at hypersonic speeds. The experimental techniques that are of immediate practical interest in view of the difficulty of flight testing are discussed in Parts D and E. This publication is beneficial to engineers involved in advanced design problems.

This study was undertaken in response to a request by the U.S. Air Force that the National Research Council (NRC) examine whether the technologies that underlie the concept of a hypersonic, air-launched, air-breathing, hydrocarbon-fueled missile with speeds up to Mach 81 can be demonstrated in time to be initially operational by 2015. To conduct the study, the NRC appointed the

Committee on Review and Evaluation of the Air Force Hypersonic Technology Program, under the auspices of the Air Force Science and Technology Board.

"The book is divided into two parts based on the overall goals, with the first part focusing on fundamental considerations, and the second part dedicated to describing computer simulation methods. The first section covers three different areas: (1) kinetic theory, (2) quantum mechanics, and (3) statistical mechanics. Important results from these three areas are then brought together to allow analysis of nonequilibrium processes in a gas based on molecular level considerations. Chapter 1 covers kinetic theory, in which the basic idea is to develop techniques to relate the properties and behavior of particles, representing atoms and molecules, to the fluid mechanical aspects of a gas at the macroscopic level. This requires us to provide a basic definition by what is meant by a particle, and how these particles interact with one another through the mechanism of inter-molecular collisions. This leads us into a discussion of modeling of macroscopic molecular transport processes, such as viscosity and thermal conductivity, that represents one of the first key successes of kinetic theory. We will find that kinetic theory relies on the use of statistical analysis techniques, such as probability density functions, due to the very large volumes of information involved in tracking the behavior of every single particle in a real gas flow"--

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

This is an introductory level textbook which explains the elements of high temperature and high-speed gas dynamics. Readers will gain an understanding how the thermodynamic and transport properties of high temperature gas are determined from a microscopic viewpoint of the molecular gas dynamics, and how such properties affect the flow features, the shock waves and the nozzle flows, from a macroscopic viewpoint. In addition, the experimental facilities for the study on the high enthalpy flows are described in a concise and easy-to-understand style. Practical examples are given throughout emphasizing the application of the theory discussed. Each chapter ends with exercises/problems and solutions to enhance the learning experience. The book begins with the basics about enthalpy, its nature and difference with internal energy and its relationship to heat. Subsequent sections in the chapter on the Basics cover the essence of the gas dynamics of perfect gas, covering all aspects of the theory, which assumes the specific heats of the gas as constants and independent of temperature. The chapter on Thermodynamics of Fluid Flow reviews the concept of energy which plays an important role in both high temperature flows and perfect gas flows. The chapter on Wave Propagation describes the waves, namely the Mach waves, compression waves and expansion waves, which prevail in all gas dynamic streams. The chapter on High Temperature Flows begins with the discussion on the difference between the perfect gas flow and high temperature flow, and proceeds to the importance of high-enthalpy flows covering the nature of high-enthalpy flows, most probable macro state, Bose-Einstein and Fermi-Dirac statistics, Boltzmann distribution, evaluation of thermodynamic properties and partition function, covering the various aspects of high-enthalpy flows with shocks. The final chapter on High Enthalpy Facilities describes the devices to provide hypersonic airflows at high enthalpy and high-pressure total conditions.

The Ideal Text/Reference for Students, Engineers, and Research Scientists Not since the early days of space flight has the subject of hypersonic flow been of such importance to aerospace and mechanical engineers, research scientists, and students. Spurred by visions of hypersonic transport, and aerospace planes, the government now supports studies of hypersonic flow in at least eighteen graduate research centers across the nation, and numerous major universities now offer graduate and senior level undergraduate courses on the subject. Hypersonic Flow is the ideal text/reference for students and professionals interested in this burgeoning field. Written by a nationally recognized authority on the subject, it features a clear, accessible writing style along with sufficient depth and detail for self-study, and it is organized for speedy location of specific information. Numerous end-of-chapter exercises and homework problems enhance and solidify the student’s understanding of complex and sophisticated material. This book provides an in-depth look at all the major topics and issues associated with fluid flow at speeds in excess of Mach 5, including: elementary hypersonic flow problems; general similarity concepts; elements of hypersonic small disturbance theory; and much more. In addition, this book brings you: The most extensive coverage of viscous effects available anywhere A unique, in-depth presentation of waveriders Extensive treatment of asymmetric conical flows An introduction to computational fluid dynamics Extensive treatment of real-gas effects

Hypersonic transition poses a special challenge for direct numerical simulations. Comparable data from Wind-tunnel tests or free-flight testing are not available or not accurate enough for comparison. The wind-tunnel testing does not allow for the exact match to the free-flight conditions at such high Mach-numbers. Flatplate boundary-layer transition at high Mach-numbers is investigated in this work. A simulation case was chosen where chemical non-equilibrium plays an important role but ionization can be neglected. The chosen case at an altitude of H=50Km lies close to one point on the descent path of the Space Shuttle. The failure of the Space Shuttle has shown that an improved vehicle for space transportation is imperative in the close future. Transition research for an improved space-transportation vehicle is crucial in order to estimate the heat load during re-entry.

Rocket and air-breathing propulsion systems are the foundation on which planning for future aerospace systems rests. A Review of United States Air Force and Department of Defense Aerospace Propulsion Needs assesses the existing technical base in these areas and examines the future Air Force capabilities the base will be expected to support. This report also defines gaps and recommends where future warfighter capabilities not yet fully defined could be met by current science and technology development plans.

A modern treatment of hypersonic aerothermodynamics for students, engineers, scientists, and program managers involved in the study and application of hypersonic flight. It assumes an understanding of the basic principles of fluid mechanics, thermodynamics, compressible flow, and heat transfer. Ten chapters address: general

characterization of hypersonic flows; basic equations of motion; defining the aerothermodynamic environment; experimental measurements of hypersonic flows; stagnation-region flowfield; the pressure distribution; the boundary layer and convective heat transfer; aerodynamic forces and moments; viscous interactions; and aerothermodynamics and design considerations. Includes sample exercises and homework problems. Annotation copyright by Book News, Inc., Portland, OR
In this book selected aerothermodynamic design problems in hypersonic vehicles are treated. Where applicable, it emphasizes the fact that outer surfaces of hypersonic vehicles primarily are radiation-cooled, an interdisciplinary topic with many implications.
"Hypersonic missiles--specifically hypersonic glide vehicles and hypersonic cruise missiles--are a new class of threat because they are capable both of maneuvering and of flying faster than 5,000 kilometers per hour. These features enable such missiles to penetrate most missile defenses and to further compress the timelines for a response by a nation under attack. missiles are being developed by the United States, Russia, and China. Their proliferation beyond these three could result in other powers setting their strategic forces on hair-trigger states of readiness. And such proliferation could enable other powers to more credibly threaten attacks on major powers. diffusion of hypersonic technology is under way in Europe, Japan, Australia, and India--with other nations beginning to explore such technology. Proliferation could cross multiple borders if hypersonic technology is offered on world markets. probably less than a decade

available to substantially hinder the potential proliferation of hypersonic missiles and associated technologies. To this end, the report recommends that (1) the United States, Russia, and China should agree not to export complete hypersonic missile systems or their major components and (2) the broader international community should establish controls on a wider range of hypersonic missile hardware and technology"--Publisher's description.

A summary is given of low density hypersonic flow research. Progress is reported on wind tunnel instrumentation based upon a technique which takes advantage of a periodic modulation of the flow to improve the signalto-noise ratio of the instruments, which include hot wire probes and force measuring balances. (Author).

The program areas included in this report are early work on the Wave Superheater and related research on Chemical Nonequilibrium in High-temperature Gas Flows, a Radiation Probe, Sound Propagation in an Excited of Dissociated Gas, Boundary Layer Phenomena in High-Temperature Gas Flows, and Molecular Interaction at High Temperatures.

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.

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.

The high temperatures generated in gases by shock waves give rise to physical and chemical phenomena such as molecular vibrational excitation, dissociation, ionization, chemical reactions and inherently related radiation. In continuum regime, these processes start from the wave front, so that generally the gaseous media behind shock waves may be in a thermodynamic and chemical non-equilibrium state. This book presents the state of knowledge of these phenomena. Thus, the thermodynamic properties of high temperature gases, including the plasma state are described, as well as the kinetics of the various chemical phenomena cited above. Numerous results of measurement and computation of vibrational relaxation times, dissociation and reaction rate constants are given, and various ionization and radiative mechanisms and processes are presented. The coupling between these different phenomena is taken into account as well as their interaction with the flow-field. Particular points such as the case of rarefied flows and the inside of the shock wave itself are also examined. Examples of specific non-equilibrium flows are given, generally corresponding to those encountered during spatial missions or in shock tube experiments.

Hypersonic and High-temperature Gas DynamicsHypersonic and High Temperature Gas DynamicsMcGraw-Hill CollegeHypersonic and High-temperature Gas DynamicsAmer Inst of Aeronautics &

Demand for high-speed propulsion has renewed development of the supersonic combustion ramjet engine (Scramjet engine) for hypersonic flight applications.

Hypersonic Flow Theory presents the fundamentals of fluid mechanics, focusing on the hypersonic flow theory and approaches in theoretical aerodynamics. This book discusses the assumptions underlying hypersonic flow theory, unified supersonic-hypersonic similitude, two-dimensional and axisymmetric bodies, and circular cylinder. The constant-streamtube-area approximation, streamtube-continuity methods, and tangent-wedge and tangent-cone are also deliberated. This text likewise covers the similar laminar boundary layer solutions, bluntness induced interactions on slender bodies, and free molecule transfer theory. The dynamics of hypersonic flight or hypersonic wing theory, magnetohydrodynamic theory, or any developments involving treatment of the Boltzmann equation are not included. This publication is intended for hypersonic aerodynamicists, students, and researchers conducting work on the hypersonic flow phenomena.