

## Space Propulsion Analysis And Design Ploverore

An understandable perspective on the types of space propulsion systems necessary to enable low-cost space flights to Earth orbit and to the Moon and the future developments necessary for exploration of the solar system and beyond to the stars.

The definitive text on rocket propulsion—now revised to reflect advancements in the field For sixty years, Sutton's Rocket Propulsion Elements has been regarded as the single most authoritative sourcebook on rocket propulsion technology. As with the previous edition, coauthored with Oscar Biblarz, the Eighth Edition of Rocket Propulsion Elements offers a thorough introduction to basic principles of rocket propulsion for guided missiles, space flight, or satellite flight. It describes the physical mechanisms and designs for various types of rockets' and provides an understanding of how rocket propulsion is applied to flying vehicles. Updated and strengthened throughout, the Eighth Edition explores: The fundamentals of rocket propulsion, its essential technologies, and its key design rationale The various types of rocket propulsion systems, physical phenomena, and essential relationships The latest advances in the field such as changes in materials, systems design, propellants, applications, and manufacturing technologies, with a separate new chapter devoted to turbopumps Liquid propellant rocket engines and solid propellant rocket motors, the two most prevalent of the rocket propulsion systems, with in-depth consideration of advances in hybrid rockets and electrical space propulsion Comprehensive and coherently organized, this seminal text guides readers evenhandedly through the complex factors that shape rocket propulsion, with both theory and practical design considerations. Professional engineers in the aerospace and defense industries as well as students in mechanical and aerospace engineering will find this updated classic indispensable for its scope of coverage and utility.

Progress in space safety lies in the acceptance of safety design and engineering as an integral part of the design and implementation process for new space systems. Safety must be seen as the principle design driver of utmost importance from the outset of the design process, which is only achieved through a culture change that moves all stakeholders toward front-end loaded safety concepts. This approach entails a common understanding and mastering of basic principles of safety design for space systems at all levels of the program organisation. Fully supported by the International Association for the Advancement of Space Safety (IAASS), written by the leading figures in the industry, with frontline experience from projects ranging from the Apollo missions, Skylab, the Space Shuttle and the International Space Station, this book provides a comprehensive reference for aerospace engineers in industry. It addresses each of the key elements that impact on space systems safety, including: the space environment (natural and induced); human physiology in space; human rating factors; emergency capabilities; launch propellants and oxidizer systems; life support systems; battery and fuel cell safety; nuclear power generators (NPG) safety; habitat activities; fire protection; safety-critical software development; collision avoidance systems design; operations and on-orbit maintenance. \* The only comprehensive space systems safety reference, its must-have status within space agencies and suppliers, technical and aerospace libraries is practically guaranteed \* Written by the leading figures in the industry from NASA, ESA, JAXA, (et cetera), with frontline experience from projects ranging from the Apollo missions, Skylab, the Space Shuttle, small and large satellite systems, and the International Space Station. \* Superb quality information for engineers, programme managers, suppliers and aerospace technologists; fully supported by the IAASS (International Association for the Advancement of Space Safety)

Liquid Acquisition Devices for Advanced In-Space Cryogenic Propulsion Systems discusses the importance of reliable cryogenic systems, a pivotal part of everything from engine propulsion to fuel deposits. As some of the most efficient systems involve advanced cryogenic fluid management systems that present challenging issues, the book tackles issues such as the difficulty in obtaining data, the lack of quality data and models, and the complexity in trying to model these systems. The book presents models and experimental data based on rare and hard-to-obtain cryogenic data. Through clear descriptions of practical data and models, readers will explore the development of robust and flexible liquid acquisition devices (LAD) through component-level and full-scale ground experiments, as well as analytical tools. This book presents new and rare experimental data, as well as analytical models, in a fundamental area to the aerospace and space-flight communities. With this data, the reader can consider new and improved ways to design, analyze, and build expensive flight systems. Presents a definitive reference for design ideas, analysis tools, and performance data on cryogenic liquid acquisition devices Provides historical perspectives to present fundamental design models and performance data, which are applied to two practical examples throughout the book Describes a series of models to optimize liquid acquisition device performance, which are confirmed through a variety of parametric component level tests Includes video clips of experiments on a companion website

Annotation This text discusses the conceptual stages of mission design, systems engineering, and orbital mechanics, providing a basis for understanding the design process for different components and functions of a spacecraft. Coverage includes propulsion and power systems, structures, attitude control, thermal control, command and data systems, and telecommunications. Worked examples and exercises are included, in addition to appendices on acronyms and abbreviations and spacecraft design data. The book can be used for self-study or for a course in spacecraft design. Brown directed the team that produced the Magellan spacecraft, and has taught spacecraft design at the University of Colorado. Annotation c. Book News, Inc., Portland, OR (booknews.com).

Endorsed by the International Association for the Advancement of Space Safety (IAASS) and drawing on the expertise of the world's leading experts in the field, Safety Design for Space Operations provides the practical how-to guidance and knowledge base needed to facilitate effective launch-site and operations safety in line with current regulations. With information on space operations safety design currently disparate and difficult to find in one place, this unique reference brings together essential material on: Best design practices relating to space operations, such as the design of spaceport facilities. Advanced analysis methods, such as those used to calculate launch and re-entry debris fall-out risk. Implementation of safe operation procedures, such as on-orbit space traffic management. Safety considerations relating to the general public and the environment in addition to personnel and asset protection. Taking in launch operations safety relating unmanned missions, such as the launch of probes and commercial satellites, as well as manned missions, Safety Design for Space Operations provides a comprehensive reference for engineers and technical managers within aerospace and high technology companies, space agencies, spaceport operators, satellite operators and consulting

firms. Fully endorsed by the International Association for the Advancement of Space Safety (IAASS), with contributions from leading experts at NASA, the European Space Agency (EASA) and the US Federal Aviation Administration (FAA), amongst others Covers all aspects of space operations relating to safety of the general public, as well as the protection of valuable assets and the environment Focuses on launch operations safety relating to manned and unmanned missions, such as the launch of probes and commercial satellites

"Frontiers of Propulsion Science" is the first-ever compilation of emerging science relevant to such notions as space drives, warp drives, gravity control, and faster-than-light travel the kind of breakthroughs that would revolutionize spaceflight and enable human voyages to other star systems. Although these concepts might sound like science fiction, they are appearing in growing numbers in reputable scientific journals.

This text describes the relationship between mission operations and the other elements of the space mission. It defines the process that translates mission objectives and requirements into a viable mission operations concept. It describes how interplanetary, international, microsatellite, and crewed missions operate.

The book addresses the overall integrated design aspects of a space transportation system involving several disciplines like propulsion, vehicle structures, aerodynamics, flight mechanics, navigation, guidance and control systems, stage auxiliary systems, thermal systems etc. and discusses the system approach for design, trade off analysis, system life cycle considerations, important aspects in mission management, the risk assessment, etc. There are several books authored to describe the design aspects of various areas, viz., propulsion, aerodynamics, structures, control, etc., but there is no book which presents space transportation system (STS) design in an integrated manner. This book attempts to fill this gap by addressing systems approach for STS design, highlighting the integrated design aspects, interactions between various subsystems and interdependencies. The main focus is towards the complex integrated design to arrive at an optimum, robust and cost effective space transportation system. The orbital mechanics of satellites including different coordinate frames, orbital perturbations and orbital transfers are explained. For launching the satellites to meet specific mission requirements, viz., payload/orbit, design considerations, giving step by step procedure are briefed. The selection methodology for launch vehicle configuration, its optimum staging and the factors which influence the vehicle performance are summarized. The influence of external, internal and dynamic operating environments experienced by the vehicle subsystems and the remedial measures needed are highlighted. The mission design strategies and their influence on the vehicle design process are elaborated. The various critical aspects of STS subsystems like flight mechanics, propulsion, structures and materials, thermal systems, stage auxiliary systems, navigation, guidance and control and the interdependencies and interactions between them are covered. The design guidelines, complexity of the flight environment and the reentry dynamics for the reentry missions are included. The book is not targeted as a design tool for any particular discipline or subsystem. Some of the design related equations or expressions are not attempted to derive from the first principle as this is beyond the scope of this book. However, the important analytical expressions, graphs and sketches which are essential to provide in-depth understanding for the design process as well as to understand the interactions between different subsystems are appropriately included.

Aerospace Propulsion Systems is a unique book focusing on each type of propulsion system commonly used in aerospace vehicles today: rockets, piston aero engines, gas turbine engines, ramjets, and scramjets. Dr. Thomas A. Ward introduces each system in detail, imparting an understanding of basic engineering principles, describing key functionality mechanisms used in past and modern designs, and provides guidelines for student design projects. With a balance of theory, fundamental performance analysis, and design, the book is specifically targeted to students or professionals who are new to the field and is arranged in an intuitive, systematic format to enhance learning. Covers all engine types, including piston aero engines Design principles presented in historical order for progressive understanding Focuses on major elements to avoid overwhelming or confusing readers Presents example systems from the US, the UK, Germany, Russia, Europe, China, Japan, and India Richly illustrated with detailed photographs Cartoon panels present the subject in an interesting, easy-to-understand way Contains carefully constructed problems (with a solution manual available to the educator) Lecture slides and additional problem sets for instructor use Advanced undergraduate students, graduate students and engineering professionals new to the area of propulsion will find Aerospace Propulsion Systems a highly accessible guide to grasping the key essentials. Field experts will also find that the book is a very useful resource for explaining propulsion issues or technology to engineers, technicians, businessmen, or policy makers. Post-graduates involved in multi-disciplinary research or anybody interested in learning more about spacecraft, aircraft, or engineering would find this book to be a helpful reference. Lecture materials for instructors available at [www.wiley.com/go/wardaero](http://www.wiley.com/go/wardaero)

Applied Space Systems Engineering is the 17th book produced by the US Air Force Academy's Space Technology Series team. The purpose of Applied Space Systems Engineering (ASSE) is to provide inspiration, processes, approaches, tools, and information for systems engineers that are leading the way in complex aerospace system design, development, and operation. An extensive author and editor team created this book based on a complete and rigorous set of systems engineer competencies rooted in the experiences and philosophies of seasoned space systems engineers from across the community. The "best of the best" performing system engineers have contributed their wealth of experience, successful tools and approaches, and lessons learned to this project. This book presents the "how-to" necessary to "systems engineer" complex aerospace-related projects, along with information to help the aspiring or current systems engineer achieve a higher level of understanding and performance. It's geared to practitioners as they work through projects, but may also serve as a primary text or reference for graduate-level courses and development programs. Many aerospace-related case studies, examples, and lessons learned are spread throughout ASSE to provide historical insights and practical applications. A companion text, Applied Project Management for Space Systems, is also available.

"Human spaceflight: mission analysis and design" is for you if you manage, design, or operate systems for human spaceflight! It provides end-to-end coverage of designing human space systems for Earth, Moon, and Mars. If you are like many others, this will become the dog-eared book that is always on your desk -and used. The book includes over 800 rules of thumb and sanity checks that will enable you to identify key issues and errors early in the design processes. This book was written by group of 67 professional engineers, managers, and educators from industry, government, and academia that collectively share over 600 years of space-related experience! The team from the United States, Austria, Canada, France, Germany, Japan, and Russia worked for four-and-one-half years to capture industry and government best practices and lessons-learned from industry and government in an effort to baseline global conceptual



design experience for human spaceflight. "Human spaceflight: mission analysis and design" provides a much-needed big-picture perspective that can be used by managers, engineers and students to integrate the myriad of elements associated with human spaceflight.

Spacecraft Structures and Mechanisms describes the integral process of developing cost-effective, reliable structures and mechanical products for space programs. Processes are defined, methods are described and examples are given. It has been written by 24 engineers in the space industry, who cover the themes of (1) ensuring a successful mission, and (2) reducing total cost through good designs and intelligent risk management. Topics include: Introduction and requirements (development process, requirements documentation, requirements definition, space mission environments); Analysis (statics, dynamics and load analysis, fatigue and fracture mechanics, mechanics of materials, strength analysis, heat transfer and thermal effects); Verification and quality assurance (verification planning, structural, mechanical and environmental testing, quality assurance and configuration control, compliance documentation, structural reliability analysis, verification criteria - factors of safety, margins of safety, fracture control, test options); Design (spacecraft configuration development, finite element analysis, mechanism development, designing for producibility, structural design, materials, designing to control loads, load cycles, sensitivity analysis); Final verification (model correlation, risk management, launch readiness reviews). For system engineers, mechanical designers, stress analysts, dynamics and load analysts, technical leads, program managers.

This is an introductory text in astronautics. It contains historical background and a discussion of space missions, space environment, orbits, atmospheric entry, spacecraft design, spacecraft subsystems, and space operations. It features section reviews summarizing key concepts, terms, and equations, and is extensively illustrated with many photos, figures, and examples Space law, politics, and economics This is a truly user-friendly, full-color text focused on understanding concepts and practical applications but written in a down-to-earth, engaging manner that painlessly helps you understand complex topics. It is laid out with multi-color highlights for key terms and ideas, reinforced with detailed example problems, and supported by detailed section reviews summarizing key concepts, terms, and equations.

Annotation "Design Methodologies for Space Transportation Systems is a sequel to the author's earlier text, "Space Transportation: A Systems Approach to Analysis and Design. Both texts represent the most comprehensive exposition of the existing knowledge and practice in the design and project management of space transportation systems, and they reflect a wealth of experience by the author with the design and management of space systems. The text discusses new conceptual changes in the design philosophy away from multistage expendable vehicles to winged, reusable launch vehicles and presents an overview of the systems engineering and vehicle design process as well as systems trades and analysis. Individual chapters are devoted to specific disciplines such as aerodynamics, aerothermal analysis, structures, materials, propulsion, flight mechanics and trajectories, avionics and computers, and control systems. The final chapters deal with human factors, payload, launch and mission operations, safety, and mission assurance. The two texts by the author provide a valuable source of information for the space transportation community of designers, operators, and managers. A companion CD-ROM succinctly packages some oversized figures and tables, resources for systems engineering and launch ranges, and a compendium of software programs. The computer programs include the USAF AIRPLANE AND MISSILE DATCOM CODES (with extensive documentation); COSTMODL for software costing; OPGUID launch vehicle trajectory generator; SUPERFLO-a series of 11 programs intended for solving compressible flow problems in ducts and pipes found in industrial facilities; and a wealth of Microsoft Excel spreadsheet programs covering the disciplines of statistics, vehicle trajectories, propulsion performance, math utilities,

The only comprehensive text available on space propulsion for students and professionals in astronautics.

Principles of Nuclear Rocket Propulsion provides an understanding of the physical principles underlying the design and operation of nuclear fission-based rocket engines. While there are numerous texts available describing rocket engine theory and nuclear reactor theory, this is the first book available describing the integration of the two subject areas. Most of the book's emphasis is primarily on nuclear thermal rocket engines, wherein the energy of a nuclear reactor is used to heat a propellant to high temperatures and then expel it through a nozzle to produce thrust. Other concepts are also touched upon such as a section devoted to the nuclear pulse rocket concept wherein the force of externally detonated nuclear explosions is used to accelerate a spacecraft. Future crewed space missions beyond low earth orbit will almost certainly require propulsion systems with performance levels exceeding that of today's best chemical engines. A likely candidate for that propulsion system is the solid core Nuclear Thermal Rocket or NTR. Solid core NTR engines are expected to have performance levels which significantly exceed that achievable by any currently conceivable chemical engine. The challenge is in the engineering details of the design which includes not only the thermal, fluid, and mechanical aspects always present in chemical rocket engine development, but also nuclear interactions and some unique materials restrictions. Sorts and organizes information on various types of nuclear thermal rocket engines into a coherent curriculum Includes a number of example problems to illustrate the concepts being presented Features a companion site with interactive calculators demonstrating how variations in the constituent parameters affect the physical process being described Includes 3D figures that may be scaled and rotated to better visualize the nature of the object under study

With the second edition of Space Mission Analysis and Design, two changes have been introduced in the Space Technology Library. Foremost among these is the introduction of the Space Technology Series as a part of the Space Technology Library. Dr. Wiley Larson of the US Air Force Academy and University of Colorado, Colorado Springs, will serve as Managing Editor for the Space Technology Series. This series is a cooperative effort of the Department of Defense, National Aeronautics and Space Administration, Department of Energy, and European Space Agency, coordinated by the US Air Force Academy. The sponsors intend to bring a number of books into the series to improve the literature base in the fundamentals of space technology, beginning with the current volume. Books which are not a part of the Space Technology Series, but which also represent a substantial contribution to the space technology literature, will still be published in the Space Technology Library. As always, we welcome suggestions and contributions from

the aerospace community.

The revised edition of this practical, hands-on book discusses the launch vehicles in use today throughout the world, and includes the latest details on advanced systems being developed, such as electric and nuclear propulsion. The author covers the fundamentals, from the basic principles of rocket propulsion and vehicle dynamics through the theory and practice of liquid and solid propellant motors, to new and future developments. He provides a serious exposition of the principles and practice of rocket propulsion, from the point of view of the user who is not an engineering specialist.

NASA's Office of the Chief Technologist (OCT) has begun to rebuild the advanced space technology program in the agency with plans laid out in 14 draft technology roadmaps. It has been years since NASA has had a vigorous, broad-based program in advanced space technology development and its technology base has been largely depleted. However, success in executing future NASA space missions will depend on advanced technology developments that should already be underway. Reaching out to involve the external technical community, the National Research Council (NRC) considered the 14 draft technology roadmaps prepared by OCT and ranked the top technical challenges and highest priority technologies that NASA should emphasize in the next 5 years. This report provides specific guidance and recommendations on how the effectiveness of the technology development program managed by OCT can be enhanced in the face of scarce resources.

**Annotation** This practical book gives young professionals all the information they need to know to get started in the space business. It takes you step-by-step through processes for systems engineering and acquisition, design and development, cost analysis, and program planning and analysis. You'll find the systems engineering and design process that applies to all space transportation systems, then the overall system architecture considerations that also apply to all space transportation systems. There is also detailed coverage of space launch vehicles by class, including the current space shuttle, other manned reusable systems, expendable systems, and future systems. A companion CD-ROM contains the Operations Simulation and Analysis Modeling System software.

A modern pedagogical treatment of the latest industry trends in rocket propulsion, developed from the authors' extensive experience in both industry and academia. Students are guided along a step-by-step journey through modern rocket propulsion, beginning with the historical context and an introduction to top-level performance measures, and progressing on to in-depth discussions of the chemical aspects of fluid flow combustion thermochemistry and chemical equilibrium, solid, liquid, and hybrid rocket propellants, mission requirements, and an overview of electric propulsion. With a wealth of homework problems (and a solutions manual for instructors online), real-life case studies and examples throughout, and an appendix detailing key numerical methods and links to additional online resources, this is a must-have guide for senior and first year graduate students looking to gain a thorough understanding of the topic along with practical tools that can be applied in industry.

The present impetus to drive down the overall cost of space missions is leading to ever-increasing demands for more efficient design techniques over a wide range of interplanetary missions, and the methods now being utilised to do this are described in this timely and authoritative work.

Readers of this book will be able to: utilize the fundamental principles of fluid mechanics and thermodynamics to analyze aircraft engines, understand the common gas turbine aircraft propulsion systems and be able to determine the applicability of each, perform system studies of aircraft engine systems for specified flight conditions, perform preliminary aerothermal design of turbomachinery components, and conceive, analyze, and optimize competing preliminary designs for conventional and unconventional missions. Early coverage of cycle analysis provides a systems perspective, and offers context for the chapters on turbomachinery and components Broader coverage than found in most other books - including coverage of propellers, nuclear rockets, and space propulsion - allows analysis and design of more types of propulsion systems In depth, quantitative treatments of the components of jet propulsion engines provides the tools for evaluation and component matching for optimal system performance Worked examples and end of chapter exercises provide practice for analysis, preliminary design, and systems integration

The only comprehensive text available on space propulsion for students and professionals in astronautics.

Throughout most of the twentieth century, electric propulsion was considered the technology of the future. Now, the future has arrived. This important new book explains the fundamentals of electric propulsion for spacecraft and describes in detail the physics and characteristics of the two major electric thrusters in use today, ion and Hall thrusters. The authors provide an introduction to plasma physics in order to allow readers to understand the models and derivations used in determining electric thruster performance. They then go on to present detailed explanations of: Thruster principles Ion thruster plasma generators and accelerator grids Hollow cathodes Hall thrusters Ion and Hall thruster plumes Flight ion and Hall thrusters Based largely on research and development performed at the Jet Propulsion Laboratory (JPL) and complemented with scores of tables, figures, homework problems, and references, *Fundamentals of Electric Propulsion: Ion and Hall Thrusters* is an indispensable textbook for advanced undergraduate and graduate students who are preparing to enter the aerospace industry. It also serves as an equally valuable resource for professional engineers already at work in the field.

The book follows a unified approach to present the basic principles of rocket propulsion in concise and lucid form. This textbook comprises of ten chapters ranging from brief introduction and elements of rocket propulsion, aerothermodynamics to solid, liquid and hybrid propellant rocket engines with chapter on electrical propulsion. Worked out examples are also provided at the end of chapter for understanding uncertainty analysis. This book is designed and developed as an introductory text on the fundamental aspects of rocket propulsion for both undergraduate and graduate students. It is also aimed towards practicing engineers in the field of space engineering. This comprehensive guide also provides adequate problems for audience to understand intricate aspects of rocket propulsion enabling them to design and develop rocket engines for peaceful purposes.

Following on from the hugely successful previous editions, the third edition of *Spacecraft Systems Engineering* incorporates the most recent technological advances in spacecraft and satellite

engineering. With emphasis on recent developments in space activities, this new edition has been completely revised. Every chapter has been updated and rewritten by an expert engineer in the field, with emphasis on the bus rather than the payload. Encompassing the fundamentals of spacecraft engineering, the book begins with front-end system-level issues, such as environment, mission analysis and system engineering, and progresses to a detailed examination of subsystem elements which represent the core of spacecraft design - mechanical, electrical, propulsion, thermal, control etc. This quantitative treatment is supplemented by an appreciation of the interactions between the elements, which deeply influence the process of spacecraft systems design. In particular the revised text includes \* A new chapter on small satellites engineering and applications which has been contributed by two internationally-recognised experts, with insights into small satellite systems engineering. \* Additions to the mission analysis chapter, treating issues of aero-manoeuvring, constellation design and small body missions. In summary, this is an outstanding textbook for aerospace engineering and design students, and offers essential reading for spacecraft engineers, designers and research scientists. The comprehensive approach provides an invaluable resource to spacecraft manufacturers and agencies across the world.

Space propulsion systems have a great influence on our ability to travel to other planets or how cheap a satellite can provide TV programs. This book provides an up-to-date overview of all kinds of propulsion systems ranging from classical rocket technology, nuclear propulsion to electric propulsion systems, and further to micro-, propellantless and even breakthrough propulsion, which is a new program under development at NASA. The author shows the limitations of the present concepts and how they could look like in the future. Starting from historical developments, the reader is taken on a journey showing the amazing technology that has been put on hold for decades to be rediscovered in the near future for questions like how we can even reach other stars within a human lifetime. The author is actively involved in advanced propulsion research and contributes with his own experience to many of the presented topics. The book is written for anyone who is interested in how space travel can be revolutionized.

Comprehensive, classic introduction to space-flight engineering for advanced undergraduate and graduate students provides basic tools for quantitative analysis of the motions of satellites and other vehicles in space.

During the last decade, rapid growth of knowledge in the field of jet, rocket, nuclear, ion and electric propulsion has resulted in many advances useful to the student, engineer and scientist. The purpose for offering this course is to make available to them these recent advances in theory and design. Accordingly, this course is organized into seven parts: Part 1 Introduction; Part 2 Jet Propulsion; Part 3 Rocket Propulsion; Part 4 Nuclear Propulsion; Part 5 Electric and Ion Propulsion; Part 6 Theory on Combustion, Detonation and Fluid Injection; Part 7 Advanced Concepts and Mission Applications. It is written in such a way that it may easily be adopted by other universities as a textbook for a one semester senior or graduate course on the subject. In addition to the undersigned who served as the course instructor and wrote Chapter 1, 2 and 3, guest lecturers included: DR. G. L. DUGGER who wrote Chapter 4 "Ram-jets and Air-Augmented Rockets," DR. GEORGE P. SUTTON who wrote Chapter 5 "Rockets and Cooling Methods," DR. . . MARTIN SUMMERFIELD who wrote Chapter 6 "Solid Propellant Rockets," DR. HOWARD S. SEIFERT who wrote Chapter 7 "Hybrid Rockets," DR. CHANDLER C. Ross who wrote Chapter 8 "Advanced Nuclear Rocket Design," MR. GEORGE H. McLAFFERTY who wrote Chapter 9 "Gaseous Nuclear Rockets," DR. S. G. FORBES who wrote Chapter 10 "Electric and Ion Propulsion," DR. R. H. BODEN who wrote Chapter 11 "Ion Propulsion," DR.

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. Written to answer the question of how to design rockets, Space Propulsion Analysis and Design provides readers the ability to complete a basic system configuration, mass estimate, and an estimate of the system's performance. Written by 16 engineers with decades of space design experience, this book offers advice, tested configurations, and historical precedents for rocket performance. The book covers the basics of rocket design, major technology types such as liquids, solids, hybrids, nuclear, and electric, plus a mission design example and discussion of future possibilities for space propulsion. Written for practicing systems and propulsion engineers, managers, and engineering students, this book gives readers a practical handbook to the design and configuration of rocket systems.

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