

Orbital Mechanics For

Orbital Mechanics for Engineering Students Elsevier

Orbital mechanics is a cornerstone subject for aerospace engineering students. However, with its basis in classical physics and mechanics, it can be a difficult and weighty subject. Howard Curtis - Professor of Aerospace Engineering at Embry-Riddle University, the US's #1 rated undergraduate aerospace school - focuses on what students at undergraduate and taught masters level really need to know in this hugely valuable text. Fully supported by the analytical features and computer based tools required by today's students, it brings a fresh, modern, accessible approach to teaching and learning orbital mechanics. A truly essential new resource. A complete, stand-alone text for this core aerospace engineering subject Richly-detailed, up-to-date curriculum coverage; clearly and logically developed to meet the needs of students Highly illustrated and fully supported with downloadable MATLAB algorithms for project and practical work; with fully worked examples throughout, Q&A material, and extensive homework exercises. The investigation of minor solar system bodies, such as comets and asteroids, using spacecraft requires an understanding of orbital motion in strongly perturbed environments. The solutions to a wide range of complex and challenging problems in this field are reviewed in this comprehensive and authoritative work.

Orbital and Celestial Mechanics

Part I: The Two-Body Problem

*Studyguide for Orbital Mechanics for Engineering Students by Curtis, Howard
Statistical Orbit Determination*

Orbital Mechanics: A Learning Tool on the Main Frame

This is a short course covering introductory topics in orbital mechanics. It focuses on Satellite Perturbations.

This course is structured to present the basic concepts without the in-depth theoretical background and mathematical derivations that commonly accompany an academic presentation of the subject. My intention is to introduce orbital mechanics in a simplified manner to those with no previous background in the field, or to provide a review to those who have studied the subject previously. Readers should have a familiarity with differential and integral calculus and differential equations to help understand some of the equations presented. The form of this short course is like the many short courses I've taught at government agencies and private corporations during my thirty-five-year career as an aerospace engineering professor at Auburn University. It presents the material in a simplified outline/bullet format using many understandable figures, rather than using lengthy, detailed explanations with complex mathematical

derivations and proofs. It provides the practical equations that are useful to the practicing engineer working in orbital mechanics. The objectives of this short course are to: Review coordinate systems, time and timekeeping, basic definitions, and terminology commonly used in orbital mechanics; Present the fundamentals of two-body orbital mechanics, i.e., the study of the motion of natural and artificial bodies in space; Review Newton's Laws of Motion, Newton's Law of Universal Gravitation, and Kepler's Laws; Describe applications of two-body orbital mechanics, including launching, ground tracks, orbital transfers, plane changes, interplanetary trajectories, and planetary capture; Review alternate solutions to Kepler's Problem, including the f and g function solutions and the f and g series solutions. The material presented is usually covered in a first course in orbital mechanics except that there is no required homework, quizzes, projects, computer programs, or examinations. I believe that even a novice reading through this material will gain an in-depth understanding of two-body orbital mechanics. My former students should recognize everything in this presentation, and if they didn't learn it the first time, they can learn it now through this simplified short course with a lot less work. Orbital mechanics is not easy, but it's my goal to make it enjoyably simple once the basic laws are understood. To do so, I've attempted to present the difficult concepts as clearly as possible to facilitate that understanding. Completion of this short course should enhance the knowledge base of all those who read through its content. This short course is part of a series I've developed as a Professor at Auburn University. Others in this series that will be available soon include: Orbital Mechanics, Part II: Satellite Perturbations; State Estimation and Kalman Filtering; and Fundamentals of Inertial Navigation and Missile Guidance. If you have questions, please contact me at: ciccida@auburn.edu.

In this 'information age' satellites are playing an increasingly important role in everything from communication and navigation to the military and weather. The command and control of satellites is based on the work of Johannes Kepler (1571-1630) and the science that evolved from his fundamental theories. The physics involved in the command and control of satellites is usually categorized as orbital

mechanics. Orbital mechanics is based on the desire to predict the path of a satellite in its orbit around the earth. One of the first requirements is to develop a coordinate system that is easy to use and measure and defines the motion of body or satellite in its orbit. After this is accomplished the propagation of the orbital path needs to be calculated. There are numerous ways to do this. A seminal work in this procedure is "Fundamentals of Astrodynamics" by Bate, Mueller & White and "Methods of Orbit Determination" by Escobal. The next problem to address are the numerous perturbation effects. The most prominent of these effects are due to the fact that the earth is not a perfect sphere (it is oblate), the moon's orbit produces a periodically disruptive effect on the orbiting body; atmospheric drag, solar radiation pressure and the precession of the earth about its axis also alter the theoretical orbit.

Relativistic effects play a role in the station-keeping of the satellite as do all the above perturbations. The next step in the command and control of the satellite involves the dynamics of space flight and the mechanics of maneuvering a body in orbit by means of thrust vectors, calculating delta-v requirements. This book outlines the unclassified methods of calculating and controlling the orbits of satellites.

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Orbital Mechanics and Astrodynamical Formulae, Theorems, Techniques, and Applications

A Short Course in Orbital Mechanics

Techniques and Tools for Space Missions

Regularization in Orbital Mechanics

Models, Methods and Applications

This thesis consists of an interactive program that enables the student to study the orbital motion of satellites around the earth. The student can investigate the shape of a variety of orbits by varying the initial position and velocity of the satellite, or by supplying select orbital parameters i.e. initial orbital radius, eccentricity, and inclination. Satellite maneuvers can also be studied, like transfer orbits and inclination changes, by command velocity changes at any location in

the orbit. Also the effects of the perturbing forces due to the oblateness of the earth, drag for low earth orbits, and gravitational attraction from the sun and moon can be investigated. The orbits are displayed in either the perifocal coordinate system around a model of the earth, or the ground track can be displayed on a map of the world. Orbital data is displayed below the orbital plot. The display is enabled by the use of display integrated software system and plotting language (DISSPLA) subroutines. Orbital mechanics, Unperturbed and perturbed orbit, FORTRAN program, DISSPLA graphics.

Regularized equations of motion can improve numerical integration for the propagation of orbits, and simplify the treatment of mission design problems. This monograph discusses standard techniques and recent research in the area. While each scheme is derived analytically, its accuracy is investigated numerically. Algebraic and topological aspects of the formulations are studied, as well as their application to practical scenarios such as spacecraft relative motion and new low-thrust trajectories.

A fascinating introduction to the basic principles of orbital mechanics It has been three hundred years since Isaac Newton first formulated laws to explain the orbits of the Moon and the planets of our solar system. In so doing he laid the groundwork for modern science's understanding of the workings of the cosmos and helped pave the way to the age of space exploration. *Adventures in Celestial Mechanics* offers students an enjoyable way to become acquainted with the basic principles involved in the motions of natural and human-made bodies in space. Packed with examples in which these principles are applied to everything from a falling stone to the Sun, from space probes to galaxies, this updated and revised Second Edition is an ideal introduction to celestial mechanics for students of astronomy, physics, and aerospace engineering. Other features that helped make the first edition of this book the text of choice in colleges and universities across North America include: * Lively historical accounts of important discoveries in celestial mechanics and the men and women who made them * Superb illustrations, photographs, charts, and tables * Helpful chapter-end examples and problem sets

Orbital Mechanics and Astrodynamics

Part II: Satellite Perturbations

With Applications to the Construction of Low Energy Transfers

Topics in Astrodynamics

Applications to Asteroid, Comet and Planetary Satellite Orbiters

Orbital mechanics is a cornerstone subject for aerospace engineering students. Maintaining the focus of the first edition, the author provides the foundation needed to understand the subject and proceed to advanced topics. Starting with the solution of the two-body problem and formulas for the different kinds of orbits, the text moves on to Kepler's equations, orbits in three dimensions, orbital elements from observations, orbital maneuvers, orbital rendezvous and interplanetary missions. This is followed by an introduction to spacecraft dynamics and a final chapter on basic rocket dynamics. The author's teach-by-example approach emphasizes the analytical procedures and computer-implemented algorithms required by today's students. There are a large number of worked examples, illustrations,

*end of chapter exercises (with answers) as well as many MATLAB® programs for use in homework and projects. The text can be used for one and two semester courses in space mechanics. * A new section on numerical integration methods applicable to space mechanics problems * A more centralized and improved discussion of coordinate systems and Euler angle sequences * An expanded development of relative motion in orbit * A new section on quaternions * New worked-out examples, illustrations and homework problems * New algorithms, MATLAB® scripts and simulations * Instructor's manual and lecture slides available online * Included online testing and assessment component helps students assess their knowledge of the topics*

A lively study of orbital mechanics by the writer responsible for the computer simulations and systems analysis for the Saturn V moon rocket, Project Skylab and many others. Provides thorough coverage of all background theories, including unusual concepts and paradoxes that will enhance appreciation of this field. Includes discussion of rocket propulsion and optimization of techniques for maximizing payload and minimizing fuel consumption, plus complete coverage of the interaction of space vehicles and space bodies.

This textbook covers fundamental and advanced topics in orbital mechanics and astrodynamics to expose the student to the basic dynamics of space flight. The engineers and graduate students who read this class-tested text will be able to apply their knowledge to mission design and navigation of space missions. Through highlighting basic, analytic and computer-based methods for designing interplanetary and orbital trajectories, this text provides excellent insight into astronomical techniques and tools. This book is ideal for graduate students in Astronautical or Aerospace Engineering and related fields of study, researchers in space industrial and governmental research and development facilities, as well as researchers in astronautics. This book also: · Illustrates all key concepts with examples · Includes exercises for each chapter · Explains concepts and engineering tools a student or experienced engineer can apply to mission design and navigation of space missions · Covers fundamental principles to expose the student to the basic dynamics of space flight

Orbital Mechanics and Formation Flying

The Orbital Mechanics of Flight Mechanics

Adventures in Celestial Mechanics

Orbital Mechanics

Satellite Orbits

Statistical Orbit Determination presents fundamentals of orbit determination--from weighted least squares approaches (Gauss) to today's high-speed computer algorithms that provide accuracy within a few centimeters. Numerous examples and problems are provided to enhance readers' understanding of the material. Covers such topics as coordinate and time systems, square root filters, process noise techniques, and the use of fictitious parameters for absorbing un-modeled and incorrectly modeled forces acting on a satellite.

Examples and exercises serve to illustrate the principles throughout each chapter.

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mechanics in a simplified manner to those with no previous background in the field, or to provide a review to those who have studied the subject previously. Readers should have a familiarity with differential and integral calculus and differential equations to help understand some equations presented. The form of this short course is like the many short courses I've taught at government agencies and private corporations during my thirty-five-year career as an aerospace engineering professor at Auburn University. It presents the material in a simplified outline/bullet format using many understandable figures, rather than using lengthy, detailed explanations with complex mathematical derivations and proofs. It provides the practical equations that are useful to the practicing engineer working in orbital mechanics. The objectives of this short course are to:

- Review coordinate systems, time and timekeeping, basic definitions, and terminology commonly used in orbital mechanics.
- Present the fundamentals of two-body orbital mechanics, i.e., the study of the motion of natural and artificial bodies in space.
- Review Newton's Laws of Motion, Newton's Law of Universal Gravitation, and Kepler's Laws.
- Describe applications of two-body orbital mechanics, including launching, ground tracks, orbital transfers, plane changes, interplanetary trajectories, and planetary capture.
- Review alternate solutions to Kepler's Problem, including the f and g function solutions and the f and g series solutions.

The material presented is usually covered in a first course in orbital mechanics except that there is no required homework, quizzes, projects, computer programs, or examinations. I believe that even a novice reading through this material will gain an in-depth understanding of two-body orbital mechanics. My former students should recognize everything in this presentation, and if they didn't learn it the first time, they can learn it now through this simplified short course with a lot less work. Orbital mechanics is not easy, but it's my goal to make it enjoyably simple once the basic laws are understood. To do so, I've attempted to present the difficult concepts as clearly as possible to facilitate that understanding. Completion of this short course should enhance the knowledge base of all those who read through its content. This short course is part of a series I've developed as a Professor at Auburn University. Others in this series that will be available

soon include: Orbital Mechanics, Part II: Satellite Perturbations State Estimation and Kalman Filtering Fundamentals of Inertial Navigation and Missile Guidance
If you have questions, please contact me at: ciccida@auburn.edu David A. Cicci Auburn, Alabama

Orbital Mechanics for Engineering Students, Second Edition, provides an introduction to the basic concepts of space mechanics. These include vector kinematics in three dimensions; Newton's laws of motion and gravitation; relative motion; the vector-based solution of the classical two-body problem; derivation of Kepler's equations; orbits in three dimensions; preliminary orbit determination; and orbital maneuvers. The book also covers relative motion and the two-impulse rendezvous problem; interplanetary mission design using patched conics; rigid-body dynamics used to characterize the attitude of a space vehicle; satellite attitude dynamics; and the characteristics and design of multi-stage launch vehicles. Each chapter begins with an outline of key concepts and concludes with problems that are based on the material covered. This text is written for undergraduates who are studying orbital mechanics for the first time and have completed courses in physics, dynamics, and mathematics, including differential equations and applied linear algebra. Graduate students, researchers, and experienced practitioners will also find useful review materials in the book. NEW: Reorganized and improved discussions of coordinate systems, new discussion on perturbations and quaternions NEW: Increased coverage of attitude dynamics, including new Matlab algorithms and examples in chapter 10 New examples and homework problems

Celestial Mechanics and Astrodynamics: Theory and Practice For Engineering Students
Theory and Applications

An Introduction to the Mathematics and Methods of Astrodynamics

Fifty years after Sputnik, artificial satellites have become indispensable monitors in many areas, such as economics, meteorology, telecommunications, navigation and remote sensing. The specific orbits are important for the proper functioning of the satellites. This book discusses the great variety of satellite orbits, both in shape (circular to highly elliptical) and properties (geostationary, Sun-synchronous, etc.). This volume starts with an introduction into geodesy. This is followed by a presentation of the fundamental equations of mechanics to explain and demonstrate the properties for all types of orbits. Numerous examples are included, obtained through IXION software developed by the author. The book also includes

an exposition of the historical background that is necessary to help the reader understand the main stages of scientific thought from Kepler to GPS. This book is intended for researchers, teachers and students working in the field of satellite technology. Engineers, geographers and all those involved in space exploration will find this information valuable. Michel Capderou's book is an essential treatise in orbital mechanics for all students, lecturers and practitioners in this field, as well as other aerospace systems engineers. —Charles Elachi, Director, NASA Jet Propulsion Laboratory

Orbital Mechanics for Engineering Students, Fourth Edition, is a key text for students of aerospace engineering. While this latest edition has been updated with new content and included sample problems, it also retains its teach-by-example approach that emphasizes analytical procedures, computer-implemented algorithms, and the most comprehensive support package available, including fully worked solutions, PPT lecture slides, and animations of selected topics. Highly illustrated and fully supported with downloadable MATLAB algorithms for project and practical work, this book provides all the tools needed to fully understand the subject. Provides a new chapter on the circular restricted 3-body problem, including low-energy trajectories Presents the latest on interplanetary mission design, including non-Hohmann transfers and lunar missions Includes new and revised examples and sample problems

This book describes a revolutionary new approach to determining low energy routes for spacecraft and comets by exploiting regions in space where motion is very sensitive (or chaotic). It also represents an ideal introductory text to celestial mechanics, dynamical systems, and dynamical astronomy. Bringing together wide-ranging research by others with his own original work, much of it new or previously unpublished, Edward Belbruno argues that regions supporting chaotic motions, termed weak stability boundaries, can be estimated. Although controversial until quite recently, this method was in fact first applied in 1991, when Belbruno used a new route developed from this theory to get a stray Japanese satellite back on course to the moon. This application provided a major verification of his theory, representing the first application of chaos to space travel. Since that time, the theory has been used in other space missions, and NASA is implementing new applications under Belbruno's direction. The use of invariant manifolds to find low energy orbits is another method here addressed. Recent work on estimating weak stability boundaries and related regions has also given mathematical insight into chaotic motion in the three-body problem. Belbruno further considers different capture and escape mechanisms, and resonance transitions. Providing a rigorous theoretical framework that incorporates both recent developments such as Aubrey-Mather theory and established fundamentals like Kolmogorov-Arnold-Moser theory, this book represents an indispensable resource for graduate students and researchers in the disciplines concerned as well as practitioners in fields such as aerospace engineering.

Orbital Mechanics for Engineering Students

Fundamentals of Orbital Mechanics

Space Flight Dynamics

Orbital Motion

Compilation of Methods in Orbital Mechanics and Solar Geometry

This modern presentation guides readers through the theory and practice of satellite orbit prediction and determination. Starting from the basic principles of orbital mechanics, it covers elaborate force models as well as precise methods of satellite tracking. The accompanying CD-ROM includes source code in C++ and relevant data files for applications. The result is a powerful and unique spaceflight dynamics library, which allows

users to easily create software extensions. An extensive collection of frequently updated Internet resources is provided through WWW hyperlinks.

Although its aim is to provide the engineer and scientist with a concise treatment of the basic elements of orbital mechanics, this book should also be suitable for senior undergraduate and graduate courses. The author begins with a discussion of the physics of the two-body problem, then enters into a discussion of launching satellites into orbit.

This volume is designed as an introductory text and reference book for graduate students, researchers and practitioners in the fields of astronomy, astrodynamics, satellite systems, space sciences and astrophysics. The purpose of the book is to emphasize the similarities between celestial mechanics and astrodynamics, and to present recent advances in these two fields so that the reader can understand the inter-relations and mutual influences. The juxtaposition of celestial mechanics and astrodynamics is a unique approach that is expected to be a refreshing attempt to discuss both the mechanics of space flight and the dynamics of celestial objects. "Celestial Mechanics and Astrodynamics: Theory and Practice" also presents the main challenges and future prospects for the two fields in an elaborate, comprehensive and rigorous manner. The book presents homogenous and fluent discussions of the key problems, rendering a portrayal of recent advances in the field together with some basic concepts and essential infrastructure in orbital mechanics. The text contains introductory material followed by a gradual development of ideas interweaved to yield a coherent presentation of advanced topics.

From Kepler to GPS

Orbital Mechanics and Analytic Modeling of Meteorological Satellite Orbits

A Digital Control Perspective

Introduction to Orbital Mechanics

Revised Reprint

Designed to be used as a graduate student textbook and a ready reference for the busy professional, Orbital Mechanics, Second Edition is structured so that you can easily look up the things you need to know. Included in the second edition are two added chapters on Orbital Coverage and on Optimal Low-Thrust Orbit Transfers, updates on several chapters, and basic PC-compatible software, which can be used to solve selected problems in the text. The well-organized chapters cover every basic aspect of orbital mechanics, from celestial relationships to the problems of

space debris.

Newton was the first to realize that objects could, in theory, be sent into orbit around Earth. Explore how this works in practice, using the ideas of energy and angular momentum to study how satellites, moons, planets, and stars move through space.

Thorough coverage of space flight topics with self-contained chapters serving a variety of courses in orbital mechanics, spacecraft dynamics, and astronautics This concise yet comprehensive book on space flight dynamics addresses all phases of a space mission: getting to space (launch trajectories), satellite motion in space (orbital motion, orbit transfers, attitude dynamics), and returning from space (entry flight mechanics). It focuses on orbital mechanics with emphasis on two-body motion, orbit determination, and orbital maneuvers with applications in Earth-centered missions and interplanetary missions. Space Flight Dynamics presents wide-ranging information on a host of topics not always covered in competing books. It discusses relative motion, entry flight mechanics, low-thrust transfers, rocket propulsion fundamentals, attitude dynamics, and attitude control. The book is filled with illustrated concepts and real-world examples drawn from the space industry. Additionally, the book includes a “computational toolbox” composed of MATLAB M-files for performing space mission analysis. Key features: Provides practical, real-world examples illustrating key concepts throughout the book Accompanied by a website containing MATLAB M-files for conducting space mission analysis Presents numerous space flight topics absent in competing titles Space Flight Dynamics is a welcome addition to the field, ideally suited for upper-level undergraduate and graduate students studying aerospace engineering.

Flight Performance Handbook for Orbital Operations

Stars in Their Courses-Orbital Mechanics

Fundamentals of Astrodynamics

The orbital mechanics of relative motion and the spacecraft rendezvous problem in an elliptical orbit

Orbital Motion in Strongly Perturbed Environments

Long established as one of the premier references in the fields of astronomy, planetary science, and physics, the fourth edition of Orbital Motion continues to offer comprehensive coverage of the analytical methods of classical celestial mechanics while introducing the recent numerical experiments on the orbital evolution of

gravitating masses and the astrodynamics of artificial satellites and interplanetary probes. Following detailed reviews of earlier editions by distinguished lecturers in the USA and Europe, the author has carefully revised and updated this edition. Each chapter provides a thorough introduction to prepare you for more complex concepts, reflecting a consistent perspective and cohesive organization that is used throughout the book. A noted expert in the field, the author not only discusses fundamental concepts, but also offers analyses of more complex topics, such as modern galactic studies and dynamical parallaxes. New to the Fourth Edition: * Numerous updates and reorganization of all chapters to encompass new methods * New results from recent work in areas such as satellite dynamics * New chapter on the Caledonian symmetrical n-body problem Extending its coverage to meet a growing need for this subject in satellite and aerospace engineering, *Orbital Motion, Fourth Edition* remains a top reference for postgraduate and advanced undergraduate students, professionals such as engineers, and serious amateur astronomers.

Aimed at students, faculty and professionals in the aerospace field, this book provides practical information on the development, analysis, and control of a single and/or multiple spacecraft in space. This book is divided into two major sections: single and multiple satellite motion. The first section analyses the orbital mechanics, orbital perturbations, and attitude dynamics of a single satellite around the Earth. Using the knowledge of a single satellite motion, the translation of a group of satellites called formation flying or constellation is explained. Formation flying has been one of the main research topics over the last few years and this book explains different control approaches to control the satellite attitude motion and/or to maintain the constellation together. The control schemes are explained in the discrete domain such that it can be easily implemented on the computer on board the satellite. The key objective of this book is to show the reader the practical and the implementation process in the discrete domain. Explains the orbital motion and principal perturbations affecting the satellite Uses the Ares V rocket as an example to explain the attitude motion of a space vehicle Presents the practical approach for different control actuators that can be used in a satellite

One of the major challenges of modern space mission design is the orbital mechanics -- determining how to get a spacecraft to its destination using a limited amount of propellant. Recent missions such as Voyager and Galileo required gravity assist maneuvers at several planets to accomplish their objectives. Today's students of aerospace engineering face the challenge of calculating these types of complex spacecraft trajectories. This classroom-tested textbook takes its title from an elective course which has been taught to senior undergraduates and first-year graduate students for the past 22 years. The subject of orbital mechanics is developed starting from the first principles, using Newton's laws of motion and the law of gravitation to prove Kepler's empirical laws of planetary motion. Unlike many texts the authors also use first principles to derive other important results including Kepler's equation, Lambert's time-of-flight equation, the rocket equation, the Hill-Clohessy-Wiltshire equations of relative motion, Gauss' equations for the variation of the elements, and the Gauss and Laplace methods of orbit determination. The subject of orbit transfer receives special attention. Optimal orbit transfers such as the Hohmann transfer, minimum-fuel transfers using more than two impulses, and non-coplanar orbital transfer

are discussed. Patched-conic interplanetary trajectories including gravity-assist maneuvers are the subject of an entire chapter and are particularly relevant to modern space missions.

An Overview of Orbital Mechanics & Astrodynamics

Capture Dynamics and Chaotic Motions in Celestial Mechanics

Theory and Practice

Studyguide for Orbital Mechanics for Engineering Students by Curtis, Howard, ISBN 9780750661690

The Mathematics of Simulating & Maneuvering Objects in Orbit

Never HIGHLIGHT a Book Again! Virtually all of the testable terms, concepts, persons, places, and events from the textbook are included.

Cram101 Just the FACTS101 studyguides give all of the outlines, highlights, notes, and quizzes for your textbook with optional online comprehensive practice tests. Only Cram101 is Textbook Specific.

Accompanys: 9780750661690 .

Teaching text developed by U.S. Air Force Academy and designed as a first course emphasizes the universal variable formulation. Develops the basic two-body and n-body equations of motion; orbit determination; classical orbital elements, coordinate transformations; differential correction; more. Includes specialized applications to lunar and interplanetary flight, example problems, exercises. 1971 edition.

Celestial Mechanics and Astrodynamics

Celestial Mechanics and Astrodynamics

Handbook of Satellite Orbits

Applications to the Satellite Navigation Problem

Analytical Mechanics of Space Systems