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Book Reviews

Publishers are invited to send two copies of new books for review to Dr. I. Michael Ross, Code: AA/Ro, Department of Aeronautics and Astronautics, U.S. Naval Postgraduate School, 699 Dyer Road, Monterey, CA 93943.

Orbital Mechanics

Tom Logsdon, Wiley, New York, 1998, 268 pp., $65.00, ISBN 0-471-14636-6

This witty and engaging book is designed to provide insights into the concepts and applications of orbital mechanics, rather than formulas for detailed calculations. Many of the applications discussed are based on the author's extensive experience as an orbital mechanics specialist in the aerospace industry. The presentation style of the material is based on his considerable experience writing books and teaching short courses.

The book is divided into 10 chapters that cover virtually all aspects of orbital mechanics, however briefly in some instances. Most of the applications treated are Earth-orbiting satellites and lunar trajectories, but there is some discussion of interplanetary trajectories. Topics covered include basic orbital mechanics, historical perspectives, the orbital environment, impulsive orbit transfers and maneuvers, boost to orbit and booster rocket characteristics, satellite orbits and constellation design, and advanced technology concepts for future applications. The Index is very extensive, including topics that are mentioned only briefly as personal anecdotes of the author (e.g., his boyhood friend Johnny Hardin and his views on Sputnik, which leads to a description of the benefits of having "nothin' out there"). There is also a long List of Symbols, with some listed more than once, such as h for both angular momentum and altitude. But the reader should have no problem sorting it out. The graphs and figures are excellently done and convey information very effectively. There is a comprehensive list of a dozen or two references for each chapter that are primarily textbooks and reference books but also includes magazine articles.

Some readers may find the exclusive use of English units, such as nautical miles for orbital altitude and ft/s for velocity, to be somewhat distracting. Although these were the units historically used in the aerospace industry, the more recent shift toward metric units makes the numerical values cited somewhat less meaningful, for example, 19,300 n-mile for geosynchronous altitude.

There are a few relatively minor editorial glitches, such as displaying the gravitational constant μ in a formula in Fig. 1.4, but not defining it until Chapter 2. Geosynchronous orbit period is given as a solar day of 24 h, rather than explaining why it needs to be a sidereal instead of a solar day and why a sidereal day is slightly shorter. Gravity-assist maneuvers are described very briefly but are found only as Space-Age Slingshots in the Contents and Swing-By Maneuvers in the Index. Also, the text description does not explain the slingshot terminology but instead invokes a billiard ball analogy. The reader may be left with a muddled idea of both the physics and the terminology.

As for the utility of the book, its best use is probably as a simple and informative reference on orbital mechanics concepts and applications. It might serve as an adjunct or secondary text for a first course in orbital mechanics, but there are no problems included, and the number of equations is very limited. The book is a successful attempt at providing insights rather than computational tools for the topics considered. However, the descriptions are sometimes quite detailed, such as the optimal plane change split between the two velocity changes in a low-Earth-orbit to geosynchronous-equatorial-orbit Hohmann transfer. The book would be a useful addition to the library of anyone working in orbital mechanics, managing orbit projects, or simply interested in space flight.

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Adventures in Celestial Mechanics, Second Edition

Victor G. Szebehely and Hans Mark, Wiley, New York, 1998, 310 pp., $64.95, ISBN 0-471-13317-5

This second edition of a book originally published in 1989 by Victor Szebehely is a greatly expanded version, being almost 80% longer. The project was continued by Hans Mark after Szebehely's death in 1997, and a tribute to Victor appears at the beginning of the book.

The authors have attempted to maintain the spirit of the first book as an introductory text that discusses fundamental ideas in a way to generate interest without getting into details that can be found in other texts. New material has been added on astronautical applications such as

rocket propulsion, elementary spacecraft dynamics, and the exploration of the solar system. The Annotated List of Major Reference Books (Appendix III) has been expanded and references to a few specific books are made at the end of each of the 13 chapters.

As in the first edition there is a chapter devoted to the history of celestial mechanics with discussions of the contributions of the major figures in its development. A table also provides a chronological list of the major contributors. Victor liked to tell the story of someone who complained about being left off the list. Victor advised this person that he should be happy to be excluded because all the people on the list were dead. Alas, we can now add Victor's name to that list.

The book generally succeeds in its mission as a first-course textbook that introduces a variety of concepts in orbital mechanics. The chapter on spacecraft dynamics is helpful but very limited. There are worked examples at the end of most of the chapters. Problems are also included but usually only two or three for each chapter.

Having said that the book generally accomplishes its mission, let me point out a few shortcomings of which the reader should be aware. The inclusion of gravity-assist trajectories is mentioned in the Preface as an improvement to the first edition. However, one does not find that term in the Index or chapter titles; it is only found in the history discussion in the Planetary Exploration chapter. The concept appears in the Index as the Slingshot Effect and that term is used in a brief analysis, where the maneuver is oversimplified as an elastic collision of the spacecraft with the planet as a hard sphere. In a numerical example of a Jupiter gravity-assist maneuver following a Hohmann transfer, the spacecraft aphelion velocity (surprisingly called apogee velocity) is incorrectly calculated to be about 6000 km/hr too small by misuse of a formula from an earlier chapter. The incorrect statement is then made that the spacecraft picks up twice the velocity of Jupiter. The final heliocentric spacecraft velocity is calculated to be significantly higher than the heliocentric escape speed, but the correct value for their collision model is only slightly above escape speed. And this value is too large because the collision model, besides confusing the physics of the situation, overestimates the velocity gain by assuming an unrealistic hyperbolic turn angle of 180 deg.

The section on Lambert's theorem is somewhat problematic. The theorem itself is incorrectly paraphrased (but is correct in the first edition), failing to emphasize that the time of flight depends explicitly on only the endpoints and the semimajor axis but not the eccentricity. The long derivation of Lambert's equation is a bit out of character with the rest of the book, where results are simply quoted or presented very simply and then discussed. Also, the fundamental difference between Kepler's equation and Lambert's equation is missed. The statement is made that the only difference between the two is the choice of origin for the coordinate system (i.e., the center of the ellipse for the eccentric anomaly vs the focus of the ellipse for the transfer angle). But the fundamental difference is that Kepler's equation describes an initial value problem, whereas Lambert's equation describes a boundary value problem. Also, for an elliptic orbit, no warning is given (as in the first edition) of the need to be careful because of nonunique solutions.

The historical information in the Planetary Exploration chapter, along with the photographs and descriptive references, provide interesting, nonmathematical material that should appeal to all readers. Similarly, the descriptive discussion of multibody problems and solar system stability in the final chapter is very readable and interesting.

In summary, this book generally succeeds as an updated and improved presentation of the material in the first edition. With the caveats mentioned, the book could serve as an introductory textbook or as a useful addition to a professional library.

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