Book Review

Fundamentals of Astrodynamics and Applications (2nd edition)
David Vallado, Microcosm Press, EI Segundo, CA, and Kluwer Academic Publishers, Norwell, MA, 2001, 958 pp., $54.75, ISBN 1-881883-12-4

Second editions of engineering texts often fail to deliver more than just technical and typographical corrections. Fortunately, the relative ease of posting errata on the Web has freed authors to take broader perspectives and make more creative changes in subsequent editions of the printed work. In this case, Vallado has successfully reorganized several sections and rewritten a number of others, resulting in both a stronger textbook and stronger technical reference.

Much of its basic character remains unchanged; it takes a very practical (and effective) approach to analysis and computation in astrodynamics, covering a substantial range of topics. Mathematical derivations, with varying degrees of detail, lead into a generous number of example applications devoted almost exclusively to Earth-orbiting spacecraft; the analysis is also nicely integrated with a set of algorithms suitable for straightforward computer coding.

The first chapters have been restructured to give a more logical flow of introductory material in the early history of astrodynamics, development of the two-body problem, various sets of orbital elements, and coordinate and time systems. This alone would make it more appealing as a textbook or for self-guided study; however, the author has also rewritten and expanded a number of the derivations and examples (in particular, the sections dealing with coordinate systems and Kalman filtering). Further, he has written subroutines for all 70 algorithms (in FORTRAN, PASCAL, Ada, and C), available at no cost from the publishers' Web site. These are well documented, with references to relevant page numbers and algorithms in the book, and follow the author's sound advice on good practices in computer programming. Other new features include sections on calculating ground illumination from reflected sunlight, determining rise and set times for the moon, a list of pertinent Internet sites, three pages of frequently-needed equations (conveniently placed inside the front cover), and additional references.

The material is well organized and technically edited with the high standards characteristic of the publishers' Space Technology Library series: Chapter 1 includes early history, conic sections, and development of the two-body and *n*-body problems; Chapter 2, Kepler's problem and several solution techniques, and orbital elements (several representations); Chapter 3, coordinate systems (Earth- and satellite-based) and transformations as well as time systems and conversions; Chapter 4, observation data types, sensor systems, and data transformations; Chapter 5, solar and lunar rise/set, ground illumination, and other celestial phenomena; Chapter 6, impulsive- and finite-thrust maneuvers, relative motion, and rendezvous; Chapter 7, various methods of initial orbit determination as well as a number of solutions to Lambert's problem; Chapter 8, special perturbations, with Encke's and Cowell's methods, numerical techniques, and disturbing force models; Chapter 9, general perturbation techniques, with variation of parameters, linearized approaches, analytical methods (Kozai's and Brouwer's), and Draper Semianalytical Satellite Theory; Chapter 10, orbit determination and estimation with linear and nonlinear least squares methods, sequential-batch least squares, linear and extended Kalman filters, and differential corrections; and Chapter 11, mission analysis, orbit geometries, special orbit types, the global positioning system, satellite look angles, and methods for determining close approaches. Three appendices comprise a dictionary of symbols, the Jacchia-Roberts and Russian GOST atmospheric models, mathematical fundamentals, physical constants, and expansion approximations of planetary orbital elements.

Overall, I recommend this book for use as a text in an upper-division undergraduate or graduate course. It is certainly a useful reference with an excellent index and citations of references with even more detail.

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