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Book Review

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Understanding Space: An Introduction to Astronautics

Jerry Jon Sellers, McGraw–Hill, New York, 1994, 655 pp., $46.06, ISBN 0-07-057027-2

As stated in the Preface, this textbook is intended for use in a first course in astronautics. To this end, it accomplishes its main objective marvelously. The principal author gets a lot of help from various contributors (from the U.S. Air Force Academy), who are acknowledged throughout the text. The contributors acknowledged on the cover are William J. Astore, K. Stephen Crumpton, Chris Elliott, and Robert B. Giffen. The authors' genuine love for astronautics is quite infectious as they encourage the reader to join them in their excitement. This love is readily apparent in the enormous amount of work that went into writing this book.

The book contains 16 chapters and 7 appendices. Each chapter begins with a page that broadly itemizes the concepts to follow as well as the prerequisites necessary to understand the material. Each section and chapter ends with a review of what was covered. I welcome this style and wish other authors would follow it. The first two chapters motivate the need to explore space and include the elements of a space mission architecture. This is followed by an overview of the space environment that even includes a cursory description of the "South Atlantic Anomaly." Chapters 4–9 provide an excellent coverage of astrodynamics. These six chapters gradually cover the two-body problem, orbital elements, orbital maneuvers, interplanetary transfers, orbital perturbations, and launch analysis. Particularly noteworthy in the coverage of these topics is the way the authors motivate each concept and carefully explain it in several different ways. I cannot but applaud this well-crafted presentation. In these chapters and elsewhere the authors repeatedly note that the term zero-gravity is incorrect and that the correct term to use is free-fall. This is particularly important because many introductory textbooks do not elaborate on the difference between a misnomer and the literal meaning of a term. As an educator myself, I am constantly faced with the task of forcing students to unlearn ingrained misconceptions. Consequently, I was surprised when the authors appeared to suggest that Newton's second law of motion applies to variable mass systems by writing $\boldsymbol{F} = \Delta(m\boldsymbol{V})/\Delta t = m\Delta\boldsymbol{V}/\Delta t + \boldsymbol{V}\Delta m/\Delta t$ [p. 100, Eqs. (4–6)]. Although this is just one equation in a book that contains hundreds of equations, I feel compelled to point this one out because it is one of those terrible misconceptions that appear to take permanent root in young minds. Apparently, Wiesel[1] has also noticed this often enough that he makes a special mention of it in his book on spaceflight dynamics. In fairness to the authors of the present book, they do provide a correct derivation of the rocket equation in Appendix C.

The next chapter is on re-entry. The subject is wonderfully covered in descriptions of trajectory options and vehicle design. My only disappointment here is that the authors stated the atmospheric force equation instead of "deriving" it from fundamental principles. I agree that the authors have a challenging task in introducing a vast array of concepts and hence probably cannot be criticized for missing out on a few derivations. However, as one of the main goals of education is to get students excited enough to make them seek a deeper understanding of the concepts, I would argue that providing a few pages of text on the joy of modeling is absolutely necessary in a book that is 655 pages long.

The final six chapters cover payload and spacecraft design, control systems, subsystem design considerations, propulsion, communication networks, and the economics of the space business. Although this material is covered very well, it is not discussed in the same depth as are the subjects of the preceding chapters, perhaps because this would be a tall order. The authors created such a high standard for themselves in deftly writing the earlier chapters that the subsequent ones, although very good, are not on a par. For example, in the chapters dealing with astrodynamics, the authors explain Kepler's laws and show how Newton's laws of motion and gravity provide the glorious unification. In keeping with this standard, I was expecting the chapter on remote sensing to begin with Planck's law and lead to a derivation of Wien's displacement law and the Stefan–Boltzmann equation. Instead, these are stated as independent laws of electromagnetic radiation.

In trying to get students excited about exotic propulsion systems, the authors predict (p. 499) that "… by the 23rd century, some future Chuck Yeager will break another speed barrier and take the spacecraft beyond the speed of light." One can dismiss this as a tongue-in-cheek statement; however, in a preceding paragraph the authors state that "… travel at near the speed of light is well beyond current technology." I think this hurts more than it accomplishes because the authors seem to erroneously equate science with technology. I wish such statements were missing from this otherwise marvelous book.

The style of the book is very refreshing. It is clear that the authors wrote this book in their role as educators, a fundamental notion that seems to escape quite a few

writers of textbooks. The colors blue and red are used cleverly throughout the book. The blue text and figures are very pleasing. Red is used for highlighting the first appearance of key concepts. This virtually eliminates one's unpleasant desire to ruin a book with a yellow marker. Quite a few of the illustrations are artistically drawn. I enjoyed their style, particularly because it was apparent that illustrator Dale Gay knew when to exercise artistic license and when to avoid it. A few of the figures are identical to the ones found in the textbook *Space Mission Analysis and Design*, edited by Larson and Wertz.[2] This is not surprising because Larson is the managing editor of the present book. However, I wish Gay had redrawn these figures to give this book a more unsullied style.

The book contains a number of example problems that are worked out in detail. The answers to the numerical problems are given in one of the appendices. This book lives up to its ideal of being a user-friendly textbook. I highly recommend it for an introductory college course in astronautics.

References

[1]Wiesel, W. E., *Spaceflight Dynamics*, 2nd ed., McGraw–Hill, New York, 1997, p. 193.

[2]Larson, W. J., and Wertz, J. R. (eds.), *Space Mission Analysis and Design*, 2nd ed., Kluwer, Dordrecht, The Netherlands, 1992.

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