

## BOOK REVIEWS

**Dynamics of space tether systems**, Vol. 83, by Vladimir V. Beletsky and Evgenii M. Levin, American Astronautical Society. Orders to Univelt, Inc. P. O. Box 28130, San Diego, California 92198, 1993, pp. 508, \$120.

Tethered satellites are a new concept in the western world. The authors believe that they have originated with Tsiolkovskii in 1895. One hundred years later, tethers have become a reality. The technology of tethered satellites is still in its evolutionary stage. It goes to the credit of Beletsky and Levin to write a book on a subject still in its infancy. Beletsky is known for his earlier books on spacecraft dynamics. Both the authors have been involved in tether research for over 15 years and the book is replete with a large number of references.

Their experience is reflected in the monograph, which contains various aspects of the dynamics and control of tethered satellites. I am impressed with the belief of the authors in analytical methods in this era of computers, software and more software. In the whole book, the emphasis is on analytical techniques on simpler models for approximate solutions for a wide range rather than the (exact) computer solution of one specialized case.

The book begins with a history and the applications of tethers. The equations of motion of tethered satellites are then derived. The equations are a complicated system of partial and ordinary differential equations. In the chapter that follows, four methods of solving these equations are discussed. Subsequently, nonlinear dynamics of tethers in the absence and in the presence of the atmosphere are discussed. A whole chapter is then devoted to the study of electrodynamic tethers. Following this is the treatment of the effects of damping due to internal friction. The problems of deployment and retrieval are then dealt with. It also includes a discussion on the motion after tether release or failure. The two chapters that make up the trailing edge of the book are like dessert after a sumptuous meal; they deal with exotic ideas like a satellite anchored to the moon by a tether and future space settlements with satellites connected by flexible tethers to form a circular orbit.

The book comes along with a 1.2 Mb diskette containing a special program called 'Space tether' which simulates the motion of a pair of two tether-connected satellites on IBM-compatible PCs. The program allows for all known perturbations of tethered satellites.

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**Guidance and control 1994**, edited by R. D. Culp and R. D. Rausch, *Advances in Astronautical Sciences*, Vol. 86, AAS publication. Orders to Univelt, Inc., San Diego, CA 92128, USA, 1994, pp. 678, \$120.

This volume contains the proceedings of the 17th annual AAS Guidance and Control conference. A total of 41 technical papers are presented in six sessions on multitude aspects of navigation, guidance and control. Even though the majority of the papers are descriptive and mathematically

nonrigorous, they bring out the state-of-the-art technology and valuable lessons learnt from working with practical systems.

The first session on Advances on guidance, navigation and control has seven papers. These papers deal with wide-ranging topics such as robust control synthesis for space structures, proof of concepts test for rotating devices for scanning, JPL's control-structure interaction program, optimized resonator gyroscope for satellite reference system, Hubble telescope performance enhancement studies, rapid prototyping of flight software, and EURECA AOCS design flight experience. These references may be of greater use to a practising engineer than to an academician since they elucidate design and developmental issues and practical realistic/achievable goals.

Though on paper, Section Two on small satellite systems and technology appears as a distant cousin of the theme of the proceedings, it is definitely a pertinent topic for today. Even though the space industry is striving towards building large complex systems which can easily seduce the people into funding such an extravaganza, only a tiny fraction of systems on the design table see the light of the day. Hence, one should not lose prudence in neglecting utility of cost-effective small satellites in this era of micro-miniaturization. Individually or as a constellation of satellites, these can be owned and operated by a single or conglomerate of nations/space agencies. These satellites need not have separate launch vehicles, since they can be launched with other large satellites in a piggy-back mode thus reducing the major cost of launch. To a discerning researcher, the small satellites have thrown open a plethora of R&D avenues, a minuscule part of which is reflected in six papers.

The Third session contains 11 papers out of 24 that were on story-board display on guidance, navigation and control. These narrative papers deal with basic issues that are beneficial to a novice. Brief discussions cover topics such as simulated annealing for modal reduction, radial basis function neural networks for nonlinear system identification and control, genetic algorithms for control system design, feature-based algorithms for health monitoring and failure detection. A lone paper in the tutorial section on approximate optimal guidance for aerospace systems furnishes a curt but helpful summary of modern approaches to launch vehicle guidance in addition to aero-assisted orbital plane change problems. This paper would have been very useful if it were presented in a cohesive style than the slide display format.

The proceedings also includes a section on recent experiences. The eight papers essentially present a performance audit of missions and systems like Mars Observer, ALEXIS, ASCA, Nimbus G, DSP and OLYMPUS, and GPS-based attitude determination, Megellan aerobraking. These are very valuable to researchers and practising engineers. For example, GPS-based navigation systems for position measurements have become a matter of routine, e.g., navigation system in Boeing 747 aircraft. The development of GPS-based system for attitude determination, specially for a satellite which has requirement of very high accuracy estimation for a prolonged period of operation, is definitely a challenging task. Likewise, each of the papers in this session is a storehouse of valuable experiences gained in diverse applications.

The proceedings contains latest technological developments related to *guidance and control* of aerospace systems. The presentation in majority of the papers is lucid and narrative. The papers can give clues to young researchers on the opportunities that lie ahead.

**Prestressed concrete** by N. Krishna Raju, Tata McGraw-Hill Publishing Company Limited, 4/12, Asaf Ali Road, New Delhi 110 002, 1995, pp. xxiv + 797, Rs 135.

The subject of prestressed concrete has been covered in 21 chapters. These are: Introduction, Materials for prestressed concrete, Prestressing systems, Analysis of prestress and bending stresses, Losses of prestress, Deflections of prestressed concrete members, Flexural strength of prestressed concrete sections, Shear and torsional resistance of prestressed concrete members, Transfer of prestress in pretensioned members, Anchorage zone stresses in post-tensioned members, Limit state design criteria for prestressed concrete members, Design of prestressed concrete sections, Design of pretensioned and post-tensioned flexural members, Composite construction of prestressed and *in situ* concrete, Statically indeterminate structures, Prestressed concrete pipes and tanks, Prestressed concrete slabs and grid floors, Prestressed concrete shell and folded plate structures, Prestressed concrete poles, piles, sleepers, pressure vessels and pavements, Introduction to optimum design of prestressed concrete structures and prestressed concrete bridges. There are four appendices covering properties of prestressing steels, Constants for beam sections, Post-tensioning systems and Grouting of post-tensioned ducts.

The presentation is lucid and particularly suits the needs of under- and post-graduate students of civil engineering. The subject matter is clearly explained and the number of worked-out numerical examples illustrate the analysis and design effectively. Exercises at the end of chapters give problems with answers for the practice of the students.

A number of references are given at the end of each chapter. These would be found useful by research students and engineers who may like to get more details or make an indepth study of a particular aspect of the topic under discussion. A number of practical applications are also covered for reference by practising engineers.

The author is well known for his contributions in the field of structural concrete and this book has become quite popular with students and engineers, which is evident from the fact that it is now in its third edition and has also been translated into Indonesian language as early as 1986. The cost of the book also is not high considering the quantum of information contained in it. It will be useful to students, teachers and practising engineers.

In the copy sent to the reviewer, pages 585 to 592 and 609 to 616 have been bound upside down and at wrong places. It is hoped that this is a stray case. Additional explanations/deviations in the equations presented in certain places and for some codal equations cited may help the student considerably. Examples of this are on pages 176 (curvature due to prestress after time  $t$ ) and 262 (eqn 8.3). In Chapter 15, in the computations of secondary moments by influence coefficients (p. 511, 15.5.2), it may be noticed that in the computation of  $f_y$  if terms from energy due to axial deformation are also included, there would be no need to separately compute tertiary moments (15.8). The reader could be advised, at certain places, by suitable footnotes that the methods given are approximate but sufficiently accurate for design while theoretically more precise computations are available (with references pointing to them). Examples of this are computations of losses of prestress due to shrinkage, creep, relaxation, variation of prestress along the cable after losses due to slip and friction (not a constant as normally taken) and its influence on the analysis/design of indeterminate structures. The author may like to consider a suggestion while bringing out future editions of the book, *viz.*, it could be made into two volumes—one containing the basis of analysis and design of prestressed concrete (say, present chapters 1–15) and the second dealing with the design of prestressed concrete structures (say, present chapters 16–21 with a few

more added). Then it might be possible to provide a more detailed coverage of the subject in all its aspects.

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