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Book Reviews

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Introduction to Structural Dynamics and Aeroelasticity

Dewey H. Hodges and G. Alvin Pierce, Cambridge University Press, New York, 2002, 170 pp. $55.00

Professors Hodges and Pierce provide a welcome addition to the textbooks available to those with interest in aeroelasticity. This addition is of particular importance due to the out-of-print lack of availability of the classic texts by authors such as Bisplinghof, Ashley, Halfman, Fung, and Scanlon. As a textbook, it serves as an excellent resource for advanced undergraduate and entry-level graduate courses in aeroelasticity. Following a brief introductory chapter, the textbook is divided into three primary chapters: structural dynamics (65 pp.), static aeroelasticity (30 pp.), and aeroelastic flutter (35 pp.). In addition, the authors include a supplementary appendix that provides a valuable review of Lagrange's equation. Each of the three major chapters provides numerous problems appropriate for practice and homework exercises.

The first major chapter serves as a review and foundation in structural dynamics. In this chapter the reader is presented with the development of the equations of motion and the solution to the uniform string, uniform beam torsion, and uniform beam bending. The free vibration problem is examined, providing the reader with knowledge of natural frequencies, natural mode shapes, and the general principles behind modal solutions. The reader is also introduced to approximate solution techniques such as the Ritz method and Galerkin's method.

The second major chapter addresses static aeroelastic phenomena. The authors examine several illustrative models of aeroelastic divergence, control (aileron) reversal and lift effectiveness. In these examples, the authors use a traditional academic approach of examining aeroelastic behavior by considering a rigid structure attached to a flexible support. Then the authors introduce flexible structures by considering a uniform structure with aerodynamic strip theory. In these sections, the authors examine divergence, load effectiveness and distribution, and sweep effects. The authors conclude the chapter with a brief section on aeroelastic tailoring.

The third major chapter describes flutter. The authors briefly review flutter in the context of stability analysis, followed by an examination of the traditional two-degree-of-freedom wing section that introduces terminology and aeroelastic behavior by considering quasistatic (instantaneous angle-of-attack) effects. Then the authors examine flutter analysis limited to one- or two-degree-of freedom cases but expanded to include more general models of unsteady aerodynamics. The authors include a very appropriate section titled "Engineering Solutions for Flutter." In this section the authors briefly describe the practical use of the k method and p–k methods and use the work of Hassig to compare these methods. Descriptions of unsteady aerodynamic load models are limited to Theodorsen's theory and the finite-state theory of Peters et al. The authors connect the use of Ritz and Galerkin methods in aeroelastic analysis by considering the assumed modes method and conclude the chapter with a discussion of the flutter boundary in general.

The authors do miss the opportunity to more fully discuss current practices in aeroelasticity that include modes derived from finite element models of the structure, panel methods such as the doublet-lattice method to determine the unsteady aerodynamic loads, related matrix solutions, and state-of-the-art time domain computational structural and fluid dynamic approaches. Yet, as stated by the authors, the focus is to provide an educational resource for instruction of aeroelasticity concepts to advanced undergraduates and entry-level graduates, and it accomplishes this goal very nicely. Furthermore, practicing engineers interested in a background in aeroelasticity will find the text to be a friendly primer. As a footnote, the textbook does not have a formal solution manual available to those of us who may lack confidence in our own work; however, Professor Hodges will provide his personal solutions (several of which employ Mathematica) upon request.

Thomas W. Strganac
Texas A&M University

Creep Mechanics

Josef Betten, Springer-Verlag, New York, 2002, 338 pp., $89.95

Although the title of the book is *Creep Mechanics*, the author presents the principles, methods, and results of application of the theory of tensor functions to modeling various types of behavior of isotropic and anisotropic materials. The book itself is composed of 13 chapters. In the first three chapters the author reviews in great detail basic elements of vector and tensor calculus as well as basic concepts of continuum mechanics. Chapter 4 is devoted to a general presentation of creep behavior and creep models. However, an overview of creep test results for different materials, which motivate the theories presented, is given only in the final chapter of the book. The fifth chapter is concerned with applications of the models to the description of creep of thick-walled tubes. Detailed examples are completed with numerical simulations. In the sixth chapter, the author discusses the creep potential hypothesis and shows that in the case of anisotropic materials this hypothesis leads to strong restrictions on the form of the constitutive equations. The discussion specializes to modeling anisotropic behavior, which can be described through a fourth-order linear tensor. The author presents main results concerning the theory of representation of tensor functions and methods for obtaining irreducible generating sets of invariants and thus provides the reader with general, rigorous, and powerful analytical tools for development of invariant formulations. Furthermore, in the seventh chapter the author shows how these methods can be used to obtain a general and rigorous description of damage. The remaining chapters are devoted to a review of classic viscoelasticity and viscoplasticity. Although each of these chapters contains a detailed presentation of classical models, it would have been advantageous to the reader for the author to comment on the range of validity and the conditions for using these models for different types of materials.

The bibliography contains references to about 300 titles of which over 50 are original contributions of the author. The book is a useful reference to researchers and graduate students interested in theoretical and applied continuum mechanics.

Oana Cazacu
University of Florida