Struct Multidisc Optim (2006) 32: 169–170
DOI 10.1007/s00158-006-0016-z

BOOK REVIEW

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Structural sensitivity analysis and optimization, volumes 1 and 2 by K. K. Choi and Nam-Ho Kim

xvii + 767 pages, 134 illustrations, bibliography of 137 entries, subject index. Springer Mechanical Engineering Series, Springer New York, 2005

Received: 1 March 2006 / Published online: 15 June 2006

This recent book by K. K. Choi and Nam-Ho Kim deals with all aspects of sensitivity analysis for structural systems. The book provides a nice and timely update on the classic text by Haug, Choi, and Komkov [3], as well as the treatments by Sokolowski and Zolesio [7], by Kleiber et al. [4], and by Delfour and Zolesio [2] (see also the recent survey paper [8]). The book constitutes a substantial text and go into great detail, covering discrete models, or discretized models, general variational settings (continuum sensitivity analysis), and static and dynamic problems, in both a linear and a nonlinear setting.

The book is a research monograph, but the structure and completeness of the presentation means that the book constitutes a good basis for an advanced graduate course. There are many instructive examples throughout the book and it gives a clear exposition of the mathematical and computational aspects of the area. The exposition concentrates on the continuum formulations for both the analysis models and the design sensitivity analysis, with the adjoint method for sensitivity analysis being at the "center of the stage." This means that the terminology of functional analysis is an integral tool for the presentation; however, many of the examples and the implementation sections can be read without prior knowledge of this area of mathematics.

The book consists of four parts (evenly divided between the two volumes). Part 1 deals with the background terminology and modeling paradigms used for analysis and for design, and includes chapters on variational methods and associated finite element formulations. Part 2 covers design sensitivity analysis of linear systems, and the material here is structured in a classical fashion by starting out with discrete systems (or discretized systems), moving on to continuum sizing problems, then on to shape sensitivity analysis, and ending up with configuration sensitivity analysis. Here, the latter subject is rather unique, as it treats problems of built-up structures. The problems treated range over static and transient problems, and eigenvalue problems are analyzed in great detail. Part 3 moves on to nonlinear problems, again covering sizing, shape, and configuration design settings. Finally, part 4 goes into details on the implementation aspects of design sensitivity analysis, first covering discretization schemes for the representation of design, and ending up with a number of advanced application examples.

It is difficult in a limited space to go into much detail about the material in the book. One highlight is the elaboration on the differences in working with the reduced stiffness matrix and with the generalized stiffness matrix. This is seldom made precise and it is helpful to have this covered in detail in a text like this. There are many other like details that readers will appreciate when using the book for their research projects. With this care put into the text, it was somewhat surprising to see that the semianalytical method (see [1] and references therein) is not given the same detailed treatment; this method is a rather popular approach and the limitations of this approach should always be carefully considered. The use of automatic differentiation techniques is also not included in the book; such methods are gaining in popularity and are quite efficient, for example for fluid dynamics problems [5]. Also, the rather intricate concept of the topological derivative (see, e.g., [6]) is not mentioned. However, these omissions are natural and should not distract from the general solid impression that this book leaves on the reader.

The book is a welcome, up-to-date addition to the literature in the area and it is a must as a reference volume for any research group working in sensitivity analysis and design optimization.

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