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BOOK REVIEWS

GLOBAL OPTIMIZATION IN ENGINEERING DESIGN, 1996, editor I. E. Grossmann, The Netherlands: Kluwer Academic. ix +387 pp. Price (hardcover) £108. ISBN 1-55938-210-4.

This book is the ninth in the series *Nonconvex Optimization and its Applications*, published by Kluwer Academic. It consists of 12 stand-alone papers that discuss the theory and practice of using deterministic methods to solve engineering design problems. Most of the papers assume that the reader is well versed in standard mathematical programming techniques, and also the previous work of the authors. Clear citations are given, and each chapter ends with a complete reference list.

The book is roughly divided into three sections, with chapters 1–6 explaining and testing algorithms, chapters 7–10 concentrating on applications of existing algorithms, and chapters 11 and 12 discussing how to formulate problems ready for optimization with deterministic techniques. Most of the examples given are based in chemical engineering. The content of the book follows.

Chapter 1 presents a new method for bounding non-linear programs. This is subsequently implemented in the branch and bound algorithm presented in chapter 2. Chapter 1 also contains a short history describing the use of deterministic procedures within engineering design, thus providing a good introductory chapter to this book. Computational results using a standard set of test problems are listed within chapter 2. Chapters 3 and 4 follow a similar format. Chapter 3 presents new formulations to an existing algorithm, in this case the GOP algorithm (Visweswaran and Floudas), with chapter 4 containing the computational results of implementing these new strategies. Various test examples are considered, including heat exchanger/separation network problems, robust stability analysis, and pooling and blending problems. Chapters 5 and 6 both discuss the use of interval methods to solve non-convex problems. Chapter 5 explains and tests and existing interval subdivision method. The exposition is very clear, and would be useful as an introductory text on interval analysis. Chapter 6 presents and tests methods for accelerating existing interval analysis algorithms and for eliminating sub-optimal spaces from search domains.

With regard to the applications, chapter 7 discusses how to plan a chemical process network using a branch and bound algorithm. Chapter 8 discusses the inclusion of uncertainties in problem formulation for planning, scheduling and design of multi-product and multi-purpose plants. In chapter 9, a short explanation of an extension to the global optimisation method GOP (Quesada and Grossmann) for heat exchanger networks is given, along with two examples. Chapter 10 both overviews and provides different bounding approximations for the Quesada and Grossmann algorithm for solving non-linear programming problems in linear fractional and bilinear terms. Examples given include structural design, batch processes and layout design.

In chapter 11, the formulation of the optimization problem for realistically designing a water distribution network is presented. In addition to the optimal design of the pipe-network, replacement and expansion factors are taken into consideration. Their contribution to the problem is calculated using probabilistic techniques. Finally, chapter

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12 uses symbolic manipulation to reformulate existing problems into ones which can be solved by branch and bounds methods.

On an aesthetic note, more care could have been taken with the book's compilation. Continuity of font size, numbering within each chapter, and citation of references would have been preferable. In addition, although the authors' addresses are given at the start of each chapter, a list of World Wide Web addresses for cited codes would have been useful.

All in all, this book is a valuable reference text for deterministic optimisation. The theoretical content is applicable to many optimisation problems. In particular, the algorithms presented may provide useful alternatives to classical, or even the modern heuristic, optimisation techniques used in many other branches of engineering design.

WILMA ALLAN

STABILITY PROBLEMS IN FRACTURE MECHANICS, 1996, by V. V. Bolotin, New York: John Wiley, 188 pp. Price $64.95; £50.00 ISBN 0-471-12546-6.

According to Richard Bellman, stability is a "much overburdened word with an unstabilized definition". If so, can and should it be applied to fracture mechanics? Bolotin's book addresses this and other questions; the answer is affirmative. Recently another book, *Stability of Structures*, by Z. Bavant and L. Cedolin (Oxford University Press, 1991), devoted an entire chapter, entitled "Fracture as a Stability Problem", to the same topic. As we can see, the interrelation between stability and fracture is becoming a popular subject both in East and West, hopefully with practically useful conclusions.

The author of the book is a truly eminent expert in stability. His first book on instability appeared 40 years prior to this one. (In passing, we note that his books and lectures have educated numerous engineers and students around the world, including this writer.) Thus, this book is a sort of "homecoming," but on another level, and on another topic. He is summarizing his recent work, which started in 1983.

Professor Bolotin has developed, apparently for the first time in fracture mechanics, an approach based on the principle of virtual work for systems with *unilateral constraints*. Cracks in structural materials are usually *irreversible*. In this context, the notion of the *sub-equilibrium state* is one of the author's principal contributions in this class of mechanical problems.

In the first chapter the author reviews linear fracture mechanics and non-linear fracture mechanics. The author notes that "anyhow, instabilities and nonlinearities are inherently mutually conditioned." The author then discusses fatigue of materials and components, as well as fatigue crack growth and final failure.

Despite the non-linearity of fracture mechanics, the author shows that stability analysis in fracture mechanics does not always require the application of stability "in the whole scale". Since the Lagrange–Dirichlet theorem is inapplicable due to the lack of potentiality, this theorem is replaced by the principle of virtual work, which is given in the second chapter, along with the definition of attendant generalized co-ordinates and generalized forces. Non-equilibrium and anti-equilibrium states are introduced.

Chapter 3 deals with single-parameter cracks and crack-like defects, along with stability of delaminations in plates and shells. Chapter 4 is devoted to multi-parameter cracks and includes discussion about the classical elliptical penny-shaped crack, as well as branching and kinking phenomena, the latter being actively pursued by investigators in the U.S.A.

Chapter 5 discusses fatigue crack propagation, while the sixth chapter analyzes dynamic crack instabilities.

As Professors Budiansky and Hutchinson have mentioned in one of their definitive reviews, ''everyone loves a buckling problem''. Will practising engineers, dealing with fracture and fatigue, fall in love with the stability approach to their problems?

It appears that the efforts of Academician Bolotin and other authors to combine stability and fracture notions should be most welcomed. We hope that practicing engineers will become acquainted with these developments, to gain a novel viewpoint on their topic. However, stability theory is not just one of the ''garments'' for the same theory; as this book shows, it is a useful approach that gives new insights and new tools.

Maybe, for some problems, this is the only sensible thing to do. How is one to know *a priori* when one has to deal with fracture and fatigue as an instability problem?

The book, by one of mechanics' prominent scientists, attempts to guide engineers along the mysterious pathways of the nature of fatigue and fracture, and sheds more light on these topics, due to the deep physical insights of the author.

The book, therefore, is an excellent addition to the shelves of engineers working in fatigue and fracture, as well as of reference libraries.

I. ELISHAKOFF

RESULTATS DE REFERENCE POUR LE RAYONNEMENT ACOUSTIQUE DES PLAQUES (BENCHMARKS FOR VIBROACOUSTIC SOFTWARE), 1996, by ''C. Valor'' (Commission de Validation des Progiciels de calcul vibroacoustique). Courbevoie: Société Française des Mécanicieus. 118 pp. ISBN 2-904983-11-2.

This publication contains the results produced in a joint study of methods of computing sound radiation from vibrating plates, performed at eleven French laboratories during the period 1992–1996, under the auspices of the Société Française des Mécaniciens and The Société Française d'Acoustique. The aim was to validate software for vibroacoustic software. This report, concerning plate vibration in air, collectively authored under the pseudonym ''C. VALOR'', is the first in the series that the Commission de Validation intends to produce. Other calculation cases, including a cylinder, a box, acoustic excitation and underwater radiation are now being examined by the commission. The report is in French, with a two-page English abstract. Chapter I consists of a six-page listing of the mathematical definitions of the physical qualities to be presented graphically, in a manner described in chapter II. Chapter III presents 15 graphical results for a simply supported baffled plate of dimensions 1 m $\times$ 1 m $\times$ 1 mm; 29 graphical results are presented in chapter IV for the same plate but of 10 mm thickness. In chapter V results are presented for the plate of chapter IV but backed by a rigid cavity. Quantities graphed include the excitation power supplied to the structure, the square of the normal velocity of the radiating surface, the total vibratory energy of the structure, the radiation factor, the acoustic energy of the cavity and the power radiated into the exterior medium, Chapter VI presents similarly detailed results for a non-baffled plate, and chapter VII those for a free unbaffled plate. Finally, pages 109–115 present graphical comparisons of calculated results with experimental ones. The report will certainly be of interest to all those concerned with the validity of vibroacoustic software.

Further information about it and the on-going work can be obtained from the Animator of the Commission, J. Tourret, fax (33) 03 44 58 36 17; E-mail tourret@alpha.cetim.fr.

P. E. DOAK