BOOK REVIEWS

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I. FOUNDATIONS & BASIC METHODS

9R1. Natural Boundary Integral Method and Its Applications. - De-hao Yu *(Inst of Comput Math and Sci/Eng Comput, Chinese Acad of Sci, Beijing, ROC).* Kluwer Acad Publ, Dordrecht, Netherlands. Distributed in USA by Kluwer Acad Publ, Norwell MA. 2002. 539 pp. ISBN 1-4020-0457-5. $155.00.

Reviewed by D Givoli (Dept of Aerospace Eng, Technion-Israel, Haifa, 32000, Israel).

Kang Feng (1923-1993) was a well-known Chinese mathematician, and until his death was the President of the Chinese Society of Computational Mathematics. De-hao Yu, the author of this book, was his PhD student. This is an English version of a previous monograph by Yu that appeared in Chinese ten years ago. The book summarizes Yu's research work based on the mathematical foundation laid by Feng. Most of Feng's and Yu's publications have appeared in Chinese and have not been generally accessible to western readers. This monograph, published by Kluwer, is especially welcome since it allows general access to the interesting work of both Feng and Yu.

The book focuses on the concept of Natural Boundary Reduction (NBR) in the context of two-dimensional (2D) elliptic problems, and in particular problems governed by Laplace's equation, the biharmonic equation, plane elasticity equations, and Stokes' equations. The idea is to replace the differential equation in the given 2D domain Ω by an integral equation on its boundary Γ, and to solve this integral equation numerically on Γ via a variational formulation. This sounds like the basic idea of the Boundary Element Method (BEM); however, in NBR the reduction of the differential equation in Ω to an integral equation on Γ is performed differently, using the so-called natural integral operator, which is also known as the Dirichlet-to-Neumann (DtN) map.

The book is written beautifully. It is very clear, interesting, and not dry despite being mathematically rigorous. Although the author is a mathematician, he wrote this book in a way that makes it accessible to mathematically-oriented graduate students and researchers in computational and applied mechanics and engineering. The basic ideas are described clearly and in a well-organized way. In addition, one can learn quite a lot from this book about areas as diverse as singular integrals, harmonic functions, and domain decomposition. The summary on singular integrals in Section 1.4, for example, is superb.

The book, with 540 pages, is divided into seven chapters. Chapter 1 introduces the main ideas of NBR, and is followed by Chapters 2–5, which apply the method to the four differential equations mentioned above. Chapter 6 discusses the coupling of NBR and Finite Elements. This is similar to the DtN method, which has been devised independently in the west primarily for wave problems (which are not discussed at all in this book). The last chapter shows how to solve unbounded domain problems using NBR combined with iterative Domain Decomposition. The book also includes a preface (telling about Prof Feng), a list of more than 200 references (about half of which are Chinese publications), and an index.

The NBR method is described on the back cover as a competitor to the standard BEM. Such a comparison is not totally appropriate. The BEM is a general method that can handle problems in irregular geometries. It makes use of the *full-space* Green's function associated with the operator involved, which does not depend on the given geometry. On the other hand, NBR makes use of the natural integral operator, which depends on the specific geometry under consideration. Finding this operator on Γ (analytically) is equivalent to solving the problem in Ω analytically. Thus, in its simplest form, the NBR method can be applied in practice only in cases where the analytic solution is already known! Of course, there is no point in using NBR in such a manner.

However, this does not mean that the idea underlying NBR is not useful. It is definitely useful when the domain of the problem under consideration involves a region where the problem is analytically-solvable *and* a region where it is not. Such problems are discussed in the last two chapters, where the practical usefulness of the method is demonstrated. In addition, understanding the various ways in which a problem can be represented (via partial differential equations, as a variational problem, by an integral equation, etc) is always beneficial and may lead to interesting insights regarding the properties of solutions and to new computational methods.

Natural Boundary Integral Method and Its Applications is neither a course textbook nor a state-of-the-art research book on a wide scientific area, but it is a satisfying self-contained summary of a very interesting piece of work that has been hidden from the western reader so far. This monograph is highly recommended as an enjoyable and eye-opening reading for the mathematically-oriented researcher and practitioner of applied mechanics.

9R2. Physics of Strength and Fracture Control: Adaptation of Engineering Materials and Structures. - AA Komarovsky *(Lab of Phys of Strength, Sci and Eng Center for Non-Traditional Technologies (SALUTA), Kiev, Ukraine).* CRC Press LLC, Boca Raton FL. 2003. 639 pp. ISBN 0-8493-1151-9. $179.95.

Reviewed by HW Haslach Jr (Dept of Mech Eng, Univ of Maryland, College Park MD 20742-3035).

The safety of engineering structures depends on the designer's ability to predict the resistance of solids to failure. The author believes that a new concept of the science of the resistance of materials is needed since existing techniques have been exhausted. In particular, because that author believes that all phenomena have an explanation, statistical methods of design are rejected. The focus of this book is on analysis of the interatomic bonds of a solid and their consequences for bulk behavior.

A good theory of the non-equilibrium thermodynamics of solids is needed to understand the response of solids to forces, heat, magnetism, and other fields. In this book, the model given closely parallels the classical analysis of fluids. The internal pressure or stress in the solid is defined as the vector representing the resistance to volume change, $\mathbf{P}=d\mathbf{F}/ds$, where $\mathbf{F}$ is the force of atomic interaction and s is the surface areas enclosing a volume. The proposed thermodynamic equation of state is then $PV=\mathbf{s}(N,V,T,\mathbf{P})T$, where $\mathbf{s}$ is the entropy vector and P is the magnitude of $\mathbf{P}$. Apparent conflicts of vectors and scalars occur frequently in the equations of this book. The given derivation is quasi-static because it assumes that the body passes through a sequence of equilibrium states.

The state of the solid is defined to be the shape of the rotos resulting from the solidification process. A rotos is a closed dynamic cell of solids. The equation of state

