BOOK REVIEWS

I. FOUNDATIONS & BASIC METHODS

11R1. Boundary Element Methods for Engineers and Scientists: An Introductory Course With Advanced Topics. - L Gaul, M Kögl, and M Wagner. Springer-Verlag, New York. 2003. 488 pp. ISBN 3-540-00463-7. $79.95.

Reviewed by JT Chen (Dept of Harbor and River Eng, Natl Taiwan Ocean Univ, PO Box 7-59, Keelung 202, Taiwan, ROC).

As the title of this book emphasizes, an introductory course to the boundary element method (BEM) and advanced formulations is presented. The book contains four parts: Part I The Direct Boundary Element Method, Part II Dual Reciprocity Method (DRM), Part III Hybrid Boundary Element Methods, and Part IV Appendix.

Part I can be seen as an introductory course, while Parts II and III cover advanced topics that contain the authors' research material. The appendices in Part VI contain some fundamental solutions and particular solutions for the DRM. Exercises and programs are not provided. The reviewer found that an on-line book of BEM by the first author is available on the web site of http://www.bem.uni-stuttgart.de/. This site provides a more friendly and suitable textbook for beginners since exercises are given.

As it is common with other BEM books, this text begins with an introduction and mathematically preliminaries. A special chapter on continuum physics is added in Chapter 3: the basic laws and constitutive equations for elastodynamics, heat conduction, electrodynamics, thermoelasticity, acoustics, and piezoelectricity are covered to provide a complete overview on the physical modeling. Chapters 4 and 5 introduce the direct BEM for potential problems of the Laplace and Navier equations with emphases on the issues of anisotropy and piezoelectricity. No indirect formulations in terms of single-layer or double-layer representations are developed. Numerical integration schemes for regular and singular integrals are addressed in Chapter 6.

Parts II and III on advanced topics include the dual reciprocity BEM and the hybrid BEM. Chapter 7 basically follows the DRM book by Partridge *et al* for a general introduction to the method. Chapter 8 focus on the solution of the DRM equation of motion and Chapters 9 and 10 present the application of the DRM to piezoelectricity and thermoelasticity. The hybrid BEM is derived from variational principles of mechanics that are reviewed in Chapter 11. Hybrid displacement and hybrid stress methods are both addressed in Chapters 12 and 13, respectively. Since the presented hybrid BEM uses the same source of variational principles as for hybrid FEM, one obtains symmetric system matrices. In contrast to symmetric Galerkin BEM, the hybrid BEM does not require a double integration over the boundary.

Although this book can be used as a text in a BEM course, it contains some original results regarding the dual reciprocity BEM and the variational formulation of the hybrid BEM. The book is thus recommended to graduate students and engineers. The authors have succeeded in fulfilling their aim of a dual-purpose textbook. In Part I, students as well as practitioners find a clear introduction to the method, whereas Parts II and III can serve as a valuable reference to researchers and engineers. The main distinction of the book in comparison to available works on the BEM may be its focus on the application of the method to anisotropy, piezoelectricity and thermoelasticity, as well as the presentation of the hybrid BEM. The book contains 488 pages with 135 figures. The quality of print and figures is adequate. In general, this is a well-written book and is recommended to individuals and libraries.

II. DYNAMICS & VIBRATION

11R2. Passive Vibration Isolation. - EI Rivin (Wayne State University, Detroit, MI). ASME Press, New York. 2003. 426 pp. ISBN 0-7918-0187-X.

Reviewed by S Naguleswaran (Dept of Mech Eng, Univ of Canterbury, Christchurch, New Zealand).

Vibration is used to agitate and to compact wet concrete into inaccessible places, in sieves to separate things, in vibratory conveyors, by dentists, physiotherapists, and so on. The effect of vibration can be pleasant—for example, a violin when played by a competent musician. There are several unpleasant effects which cause discomfort like a rough ride on a corrugated road or damage caused by chatter in a machine tool, wind sway to suspension bridges, earthquake to tall buildings, etc. Engineers often face the problem of attenuation of the amplitude of response of small to big systems through passive vibration isolation. The need to protect precision/sensitive instruments has changed vibration isolation into a specialist field. Considerable research effort has and is being directed towards passive vibration control resulting in several publications continuing to appear every year in various learned journals. Over the last couple of decades, monographs have appeared on passive vibration isolation and the book under review is a welcome addition.

The book has a preface and four chapters with the relevant references listed after each chapter. The Preface is very well written and portions may be used in introductory undergraduate or graduate lectures. It is pointed out that ''random excitations and nonlinear dynamics of vibration isolation systems each deserve a separate book.''

Chapter 1—*Dynamic Properties of Vibration Isolation Systems*: Commences with the basic analysis of the dynamics of an undamped six-degree-of-freedom system followed by single and two-degrees-of-freedom systems under viscous damping or hysteretic damping and a brief discussion on Coulomb damping. Random excitation and ''jump phenomena'' due to nonlinear spring stiffness are briefly mentioned. Nonlinear damping (like aerodynamic) is not covered.

Chapter 2—*Principles and Criteria of Vibration Isolation*: Topics discussed include the main considerations in passive vibration isolation, the selection of parameters for precision/sensitive objects, experimental selection of isolators. Vibration protection of civil engineering structures is very briefly discussed.

Chapter 3—*Realization of Elasticity and Damping in Vibration Isolators*: Briefly describes some of the types of springs in engineering use and includes the static and dynamic characteristics of metals, polymeric and elastomeric materials.

Chapter 4—*Passive Vibration Isolation Means*: Includes descriptions of various mats and pads used in vibration isolation, commercially available isolating mounts, pneumatic isolators and installation of machinery on vibration isolated foundations.

Illustrations are good and tables have useful information. One may safely ignore Eq. (1.3.1′) and the like when the book is being read casually. List of symbols is not included—inclusion of which would have lessened the effort when the book is used as a reference. Frequent use of acronyms renders the book difficult to read. For example in page 5 the acronym CMM appears but what it stands for is found in Preface page xi or in page 138. EDM stands for elastodamping materials and not ''electrical discharge machining.'' What is COTS? An-

swer: commercial off the shelf! The list of references at the end of each chapter is incomplete. For example only two publications on passive vibration isolation from the *Journal of Sound and Vibration* are listed in the book out of several which appear every year in the journal. Additional reading for topics in Chapter 3 is ''Damping of Materials and Members in Structural Mechanics'' by BJ Lazan (1968, Pergamon Press). Further general references in passive vibration isolation may be found in ''Passive Vibration Control' by DJ Meads (1998, John Wiley & Sons). Application of tuned vibration absorbers (often used in vibration isolation of machinery and tall structures) is not covered in the book under review.

The book will be a useful addition to libraries. The book is not suitable for undergraduate courses but may be used as reading material in graduate courses provided they are informed of the incompleteness of the list of references. Each vibration problem encountered in engineering will have unique features and the book will give an indication as to how to approach the problem and design/consulting engineers will find the book handy.

In the reverse of the cover page the ISBN is given as 0-7918-0187-X near the top of page and as 0-7981-0187-X near the bottom. The former is probably the correct number.

III. AUTOMATIC CONTROL

11R3. Missile Guidance and Control Systems. - George M Siouris. Springer-Verlag, New York. 2004. 666 pp. ISBN 0-387-00726-1. $299.00.

Reviewed by DB Schaechter ((Precision Pointing and Controls Tech Dept, Lockheed Martin Missiles and Space Systems, Adv Tech Center, 3251 Hanover St, Bldg 201, Org ABFS, Palo Alto, CA 94302).

The 666-page book *Missile Guidance and Control Systems* by George M Siouris is an up-to-date, well-organized, elegantly treated, and carefully presented text that could form the basis for a senior- or graduate-level year-long course in guidance, navigation, and controls, or as a reference book for anyone engaged with aspects of missile system design or development, or simply with an interest in this area. The text begins with a chapter on missile equations of motion (translational and rotational kinematics and dynamics using vector and tensor notation). Early in this chapter, transfer functions are discussed; the author making the implicit assumption that the reader is at least familiar with Laplace transforms and transfer functions. Next is a chapter that covers aerodynamics forces and torques with their implications on overall missile system design (guidance, seekers, noise, autopilots, etc.), and the design process. This is followed by a chapter on tactical missile guidance laws and sensing systems, including proportional navigation, optimal control, optimal estimation, and missile intercept. These three chapters plus the introduction could be covered comfortably in a single semester format. Chapters 5–7 then focus on missile system specifics, including a chapter on weapon delivery systems (which thankfully includes a complete acronym/definition table for many terms common to those in the missile community, but not necessarily familiar to those working outside the area), one on strategic missiles, and finally a chapter on cruise missiles, which also covers terrain matching, global positioning information, and the incorporation of both into the missile guidance equations. It should be noted that if this book were to be used in a classroom setting, it contains no ''problem sets'' that could form the basis for homework assignments.

Equations are all easy to read; nomenclature is logical throughout, easy to understand and follow; the figures are all simple, clean, and to the point; and the text itself flows eloquently. It is very evident that the book organization and presentation has been thought through carefully, that the manuscript has been carefully reviewed, and that the final product represents the fruits of what must have been long hours of preparation. It was definitely worth the effort.

In addition to the wealth of analytical material that comprises the majority of the book, the text also contains *nine* appendices that serve as a valuable, centrally located, self-contained reference: fundamental constants, a glossary, list of acronyms, standard atmospheric model, missile classification, past and present missile systems, a section on the properties of conics, radar frequency bands, and finally, conversion factors.

For a truly professional presentation of missile guidance and control systems from its earliest incarnation to literally present day applications and systems, this text is a valuable, self-contained addition to your personal library, and one that will no doubt provide a return on your (not insignificant) investment.

IV. MECHANICS OF SOLIDS

11R4. Theories and Applications of Plate Analysis: Classical, Numerical and Engineering Methods. - R Szilard. John Wiley and Sons, Inc, New York. 2004. 1056 pp. ISBN 0-471-42989-9. $225.00.

Reviewed by AE Bogdanovich (R&D, 3TEX, Inc, 109 MacKenan Dr, Cary, NC 27511).

This over 1000-page monumental volume can be, probably, best categorized as encyclopedia of plate theories, analysis methods, and applications. This is a completely reworked and greatly extended version of the same author's 1974 book *Theory and Analysis of Plates: Classical and Numerical Methods*. As the book author states in the Preface, this work tries to satisfy the requirements to a textbook, reference book and manual for practicing engineers simultaneously. This objective is very well accomplished. Indeed, the four distinct parts of the book address (i) plate theories (static, dynamic, linear, nonlinear, elastic, inelastic), (ii) analytical solutions and numerical analysis methods, (iii) examples of specific problem solutions and numerical results, and (iv) practical design methods and engineering solution procedures. There are no other available sources treating such a scope in a single book. Besides, the scope covers thin, moderately thick and thick plates, as well as very thin membranes. The book is well illustrated by large number of high quality figures, contains hundreds of references and bibliography placed at the end of each section, provides problems for individual work at the end of each chapter, and has concise subject index.

The book is based on the courses taught by the author and his research conducted at various universities in the US and Germany, as well as on his long-term experience as a practicing structural engineer. Accordingly, the book can be used as a text on plate theories, analysis methods, and their specific applications. At the same time, the volume can serve as a reference book for researchers and practicing engineers. Importantly, this volume is self-contained, i.e., no other sources are needed in most of the cases to fully understand the theories, analysis methods and specific problem solutions. In treating various plate theories and solutions of the pertinent plate problems, emphasis is placed on the fundamentals rather than on achieving exhaustive coverage of details.

The majority of plate structures is analyzed by applying the linearly elastic approach. Consequently, the main part of the book presents various linearly elastic plate theories and suitable analytical and numerical solution techniques. Plates having isotropic, orthotropic mechanical properties and composed of layered materials are considered. Significant place is allocated to large-deflection plate theory, including pertinent solution techniques, and to nonlinear elasticity and plasticity of plate materials. However, the book only slightly touches the problems of stress/strain and failure analyses of plates.

Numerical methods treated in this book include the finite difference, boundary element, gridwork, finite strip, and finite ele-

ment methods. Importantly, the aforementioned numerical methods also applied to static, dynamic, and elastic stability problems.

Practicing engineers, who must deal with ''real-life'' problems, need a much broader coverage of more complex and unique problems than one can usually find in textbooks and reference books on plate theories and analysis methods. The present book covers a large spectrum of plate problems and their solution procedures typical for mechanical and aerospace engineering, civil engineering and marine structures. In general, strong emphasis is placed on practical applications, as demonstrated by a large number of worked problems, many of them taken directly from the engineering practice.

In addition to the main volume there is a plate analysis software provided on CD attached to the book. The computer programs enable for solving a broad spectrum of diverse plate analysis problems, by either plate formulas or numerical analysis tools. A collection of 170 most important plate formulas is given on the CD. The numerical analysis programs include the FORTRAN source codes, the executable forms of those computer codes for static and dynamic analyses of plates. The CD contains finite element code WinPlatePrimer, which not only solves static and dynamic plate problems, but also teaches it users how to write such programs by using readily available subroutines.

With no hesitation this book is recommended to researchers and engineers whose work involves modeling, analysis and design of plates and plate-containing structures. The book is definitely a valuable text for graduate students studying plate theory, numerical analysis methods and their applications, as well as practical analysis and design of engineering structures. The book is highly recommended to be purchased by libraries and interested individuals.

11R5. Mathematical Theory of Elasticity. - Richard B Hetnarski and Jozef Ignaczak. Taylor & Francis, London. 2004. 821 pp. ISBN 1-591-69020-X. $134.95.

Reviewed by J Petrolito (Sch of Sci and Eng, La Trobe Univ, PO Box 199, Bendigo, Vic 3550, Australia).

This book is an advanced treatise on theoretical elasticity that is aimed at postgraduate students and researchers in the area. It s a long book, with approximately half the book devoted to fundamental principles and half to applications of the theory. The theoretical development uses a mixture of direct tensor and Cartesian tensor notation, which is summarized in the second chapter. This follows a welcome but uncommon brief biographical review of some of the major figures who have contributed to the field.

Chapters 2 to 6 cover the fundamentals of elasticity theory. Chapter 3 discusses the three basic concepts of the theory, namely stress, strain, and constitutive relationships. Chapter 4 combines these concepts to formulate the governing equations for both static and dynamic problems, including thermal effects. Variational formulations of the equations are given in Chapters 5 and 6. While there is a brief discussion on generating approximate solutions using the Rayleigh-Ritz method, these chapters primarily focus on deriving variational principles. These include the standard principles, such as the total potential energy principle, as well as less common ones such as Gurtin's variational principle in dynamics.

These solutions have both theoretical and practical applications. For example, they could be used as a starting point for boundary element methods. Chapters 8 to 10 present a variety of solutions for static two-dimensional problems. While some examples are standard, many are not usually found in textbooks in the field and are a useful addition to the literature. The last three chapters extend the examples to dynamic problems.

The theory is complemented by many examples and problems, and some the latter are at the research level. There is also an extensive list of references to the literature for further study. The theory and applications are developed in a clear and concise manner that assists in learning. While many proofs are given, some are omitted with appropriate references to other sources.

In summary, *Mathematical Theory of Elasticity* is a welcome addition to the field. Its range and scope is extensive, and it covers much material that is not usually found together in one text. The early chapters could be used as the basis for an upper-level undergraduate course that emphasizes the theoretical aspects of elasticity. The whole book succeeds in its aim of covering a broad range of elasticity theory and its applications, and can be recommended as a good reference to the field.

V. DYNAMICS OF FLUIDS

11R6. Waves and Compressible Flow - Hilary Ockendon and John R Ockendon. Springer-Verlag, New York. 2004. 188 pp. ISBN 0-387-40399-X. $59.95.

Reviewed by Reviewed by Narayanan M Komerath (Sch of Aerosp Eng, Georgia Inst of Tech, Atlanta, GA 30332-0150).

This is a textbook on applied mathematics. It describes wave phenomena from the perspective of phenomena in compressible flow—following the authors' stated belief that ''fluid mechanics provides the best possible vehicle for anyone wishing to learn applied mathematics methodology.'' As such it provides a familiar interface for aerospace engineers interested in going deeper into wave problems. The emphasis on compressible flow may or may not appeal to other students—this emphasis is certainly quite striking, in the detail and even in the wealth of illustrations in those chapters. One suggestion is to provide more illustrations in the other chapters, to convey a similar wealth of physical insight to the student. For example, the problem of wave propagation in rotating flows could use some illustrations.

Chapter 2 starts in an unsurprising manner for the engineering student, giving conservation equations. It is good to see a mathematical derivation of what is known in aerodynamics texts as the ''Helmholtz theorems.'' The exercises at the end of this chapter, as with all chapters, are very useful and well thought out.

Chapter 3 introduces acoustics from the small perturbation, linearized form of the equations of gas dynamics. It then goes on to inertial waves, waves in rotating media, and onto electromagnetic and elastic waves. This is an excellent format, but it would benefit from greater attention to the electromagnetic waves section. The treatment of the physics of electromagnetic waves is too sparse, considering that it is the only form of wave propagation across free space, devoid of a medium.

This chapter is really the most important one in this book—it integrates wave phenomena from many disciplines. As such, in any revised edition, I hope the authors will expand this to convey as much of the physics and implications as possible.

Chapter 4 describes theories for linear waves. Again, here, the treatment of two-dimensional compressible flow takes up considerable space. The illustration of a ''nephroid caustic on a cup of coffee'' is sure to cause some reflection (no pun intended) on the part of students. It is an example of the power of a well-done illustration.

Other illustrations in the chapter, however, are the typical mathematician's ''domain/set'' type blob-sketches. The exercises at the end of Chapter 4 are extensive, as appropriate.

Chapter 5 deals with nonlinear waves. The use of compressible flow here is useful, but more attention to the Schrodinger equation would also be useful to the student. The Hodograph transformation is of historical importance, but otherwise I wonder if is useful any more.

Chapter 6 presents shocks. The presentation of the shock interaction cases, showing Mach reflection is useful. The discussion of chemically reacting flows with shocks is rather skimpy—missing so many interesting aspects of detonation theory, where applied mathematics has been used to great effect in the former Soviet/Russian literature. The section on hypersonic flow is compact and very useful.

VI. HEAT TRANSFER

11R7. Thermal Analysis of Welds. - N. Nguyen. WIT Press, Southampton UK. 2004. 334 pp. ISBN 1-85312-951-8. $198.00.

Reviewed by C A Rossit (Dept of Eng, Inst of Appl Mech and CONICET, 8000 Bahia Blanca, Argentina).

This is a well-written book, which possesses an outstanding organization and clear and didactic figures.

The book provides a very complete, up-to-date coverage of known solutions to an important variety of thermal problems related to welding processes.

In the reviewer's opinion the author synthesizes analytical expressions useful for the subject but with such a degree of abbreviation that it is not possible to follow the derivation of the expressions unless one is an expert on the subject. It would have helped if specific references were provided for each formulation.

Chapter 1 introduces the characteristics of different heat sources associated with the welding process.

Chapter 2 deals with the method of analysis for solving heat conduction differential equation.

In Eq. (2.11) page 43 of this chapter one reads

$$``\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}+\frac{\partial^2 T}{\partial z^2} = \frac{1}{\alpha}\frac{\partial T}{\partial t}+f(x,y,z,t)$$

where $f(x,y,z,t)$ represents the additional heat-generation function in the body...'' and it is not clear the reason why the author places $f(x,y,z,t)$ with positive sign on the right-hand side member, since this is not usual in the classical texts of the subject matter.

On the other hand, the additional heat-generation must be divided by ''k'' in order to be compatible with the rest of the equation. After he divides it by ''k'' he could call it $f_1(x,y,z,t)$ for instance.

Chapters 3 to 7 are concerned with the derivation of the analytical solution for different kinds of heat sources in semi-infinite and infinite bodies, thin and thick plates, and cylinders and spheres.

Thus the author deals first with point, line, plane heat sources, and then by superposition principle analysis the bivariate Gaussian heat sources. Finally he focuses on the situations of spherical, single and double ellipsoidal density heat sources.

Chapters 8 to 11 are addressed to demonstrate the usefulness of analytical solutions in solving thermal problems of welded components: transient temperature distribution, thermal stresses, residual stresses, and microstructures.

The book contains three appendixes related to thermal properties of selected materials, error function characteristics, and documentation for Fortran programs developed by the author, respectively.

The book also provides a CD-Rom, with a package called WHEATSIM, which is useful for the researcher in order to simulate welding situations.

From a conceptual viewpoint it would have been interesting a short discussion, at least, of the possible importance of coupled thermal-mechanical phenomena and also dynamic effects in the case of very thin structures.

Thermal Analysis of Welds. November 2004. Applied Mechanics Reviews 57(6).Â 9: Thermal stresses and distortions Introduction General equations for thermal stress Thermal stresses of infinite body Thermal stresses in thin plate Thermal stresses in thick plate Thermal stress in beams Thermal stress in solid sphere Distortions of welds Summary Chapter 10: Modelling of residual stresses in welded joints Introduction Residual stresses in bead-on-plate weld Residual stresses in multipass gusset joint Summary. Chapter 11: Microstructure modelling of fusion welds Introduction Peak temperature Cooling rate Cooling time HAZ-width Austenitising time Grain growth modelling Micros Aspects of a methodology for inverse thermal analysis of welds are examined that provide for relaxed model-parameter optimization. These aspects are associated with the inherent insensitivity of temperature fields, obtained by inverse analysis, to local shape variations of constrained boundaries within these fields. The inverse analysis methodology is in terms of numerical-analytical basis functions for construction parametric temperature histories, which can be adopted as input data to computational procedures for further analysis. In addition, these parametric temperature histories can be us Âƒ In practice thermal analysis gives properties like; enthalpy, thermal capacity, mass changes and the coefficient of heat expansion. Âƒ Solid state chemistry uses thermal analysis for studying reactions in the solid state, thermal degradation reactions, phase transitions and phase diagrams. Thermal analysis. Includes several different methods. These are distinguished from one another by the property which is measured. Âƒ Thermogravimetric analysis (TGA): mass Âƒ Differential thermal analysis (DTA): temperature difference Âƒ Differential scanning calorimetry (DSC): heat difference Âƒ Pressurize STRESS ANALYSIS and FATIGUE of welded structures. The fatigue crack analyses were carried out for two load levels (3 000 lb and 4 000 lb) with and without residual stresses. The residual stress was combined with the cyclic stress induced by the applied load by including it [20, 21] into the Neuber or ESED equation in such a way that only the actual maximum elastic-plastic strain and stresses at the weld toe were affected.Â [11] Manson S.S.: Behaviour of materials under condi-tions of thermal stress, 1953, NACA TN-2933 and Cofn L.F. Jr., Transactions of the ASME, 1954, vol. 76, p. 931. 15. NÂ°0078 2011 Vol. 55 WELDING IN THE WORLD Peer-reviewed Section. Transient thermal analysis The analyses of both the heat sink and the spotlight dealt with heat transfer in a steady state, based on the assumption that enough time has passed for heat flow to stabilize. Analysis of a steady-state heat transfer is independent of the time it took for the heat flow to reach that steady state, which in practice may take seconds, hours, or days. An analysis of heat flow changing with time is called transient thermal analysis, as for example, the analysis of a coffee pot kept hot by a heating plate.Â Figure 21: Analysis such as thermal analysis of a circuit board is conducted using the familiar SolidWorks software interface, minimizing the need for user training. Thermal Analysis 13.