BOOK REVIEWS

Items with a reviewer byline (coded R) are by AMR's corps of dedicated outside volunteer reviewers. AMR will attempt to get critical reviews of all relevant textbooks, reference works, and monographs. Items without a reviewer byline (coded N) are prepared by AMR in-house staff and are largely based on material such as a book's table of contents and editor's preface or foreword. In the interest of timeliness, most conference proceedings and multi-author contributed volumes will receive descriptive notes in this fashion. Books deemed to be somewhat peripheral to AMR's basic scope may simply be listed by title. Also listed by title when first received are books under review.

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 relates the temperature of the solid structure to its ability to generate resistance forces. Compressions are those atoms located on the decreasing portion of a bond force minimum and provide resistance under heat adsorption, and dilatons are those located on the increasing portion to a force maximum and offer resistance in heat radiation. The compression-dilaton pattern of the bonds in a structure determines its response to loads, temperature, and other environmental conditions. Dilaton materials resist compression while compression materials resist tension. Chapter 3 provides experimental verification of this relation and its influence on the size effect, stresses, and aging in the response of solids, in particular that of concrete. The traditional design strategy of increasing the size of a structure to support loads increases the number of cracks and the possibility of crack growth.

The description of dynamic loading, durability, creep, and fatigue is developed from the equation of state to try to explain the physical nature of the time-dependent response. The increased resistance influences the initiation and propagation of cracks. Durability is related to entropy. The theory is claimed to be a generalization of the kinetic theory of strength which postulates that thermal fluctuations are key in breaking atomic bonds. In service, the equation of state describes how a structure is strongly influenced by environmental effects such as moisture, radiation, hydrogen embrittlement, and aging due to thermal and load fields.

Fracture is attributed to what is called the Maxwell-Boltzmann factor (from the distribution of energy states), which describes the concentration density and energy of particles in a given region of the solid and which introduces stress-concentrations. As in classical fracture mechanics, breaking of bonds releases internal energy. Fracture is a thermally dependent process. Deformation and fracture always occur together; fracture is not due, as postulated by others, to the breaking of the weakest link. Fatigue life is again related to thermodynamic parameters through the equation of state. Fatigue is due to phase transitions in the compression-dilaton bond pattern.

Two final chapters give applications to service life control and the theory of design. Methods of diagnosing the strength of the material described include thermography (emphasizing the thermal nature of internal stresses and strains), hardness, and durability analysis. The methods of adaptation of the materials to service conditions cover controlling the strength and fracture, heat treatment, use of compensating fields, and heterogeneity of the material.

Physics of Strength and Fracture Control: Adaptation of Engineering Materials and Structures is a serious attempt to explain bulk structural behavior from the atomic structure. However, the confusion of vectors and scalars in the mathematical expressions for the equation of state often overshadows the physical insights presented. Specific detailed applications would have helped convince the reader that this design strategy can be carried out in practice.

9N3. Error Estimation and Adaptive Discretization Methods in Computational Fluid Dynamics. - Edited by T Barth *(NASA Ames Res Center, Moffett Field CA)* and H Deconinck *(von Karman Inst for Fluid Dyn, Rhode-Saint-Genese, Belgium)*. Springer-Verlag, New York. 2003. 353 pp. ISBN 3-540-43758-4. $79.95.

This book considers recent developments in numerical error estimation and adaptive discretization for finite element and finite volume methods with particular attention given to discretization methods used frequently in computational fluid dynamics. The volume consists of six detailed articles by leading specialists covering a range of topics including a posteriori error estimation of functionals, one- and two-sided error bounds, error indicators for adaptivity, and nd geometrical aspects of adaptive mesh refinement.

9N4. Inverse Engineering Handbook. - Edited by KA Woodbury *(Univ of Alabama, Tuscaloosa AL)*. CRC Press LLC, Boca Raton FL. 2002. 640 pp. ISBN 0-8493-0861-5. $149.95.

This reference allows the readers to understand, implement, and benefit from a variety of problem-solving techniques. Each chapter details a method developed or refined by its contributor, who provides clear explanations, examples, and in many cases, software algorithms. The presentation begins with methods for parameter estimation, which build a bridge to boundary function estimation problems. The techniques addressed include sequential function estimation, mollification, space marching techniques, and adjoint, Monte Carlo, and gradient-based methods. Discussions also cover important experimental aspects, including experiment design and the effects of uncertain parameters.

9N5. MATLAB Guide to Finite Elements: An Interactive Approach. - P Kattan *(Appl Sci Univ, Amman, Jordanien)*. Springer-Verlag, New York. 2003. 385 pp. ISBN 3-540-43874-2. $69.95.

Numerical implementation of Finite Element Analysis is described using the computer program MATLAB. The book contains a short tutorial on MATLAB as well as a systematic strategy for the treatment of the finite element method. Various examples and exercises are provided out of Mechanical Engineering, Civil Engineering, Aerospace Engineering, and Materials Science. The book stresses the interactive use of MATLAB. Each example is solved in an interactive manner. The accompanying CD-Rom includes at least 50 MATLAB functions specifically written to be used with this book in the form of a MATLAB Finite Element Toolbox. An extensive solutions manual is provided as well, which includes detailed solutions to all the problems in the book for classroom use.

9N6. Selected Topics in Boundary Integral Formulations for Solids and Fluids. - Edited by V Kompis *(Univ of Eilina, Slovak Republic)*. Springer-Verlag, New York. 2003. 241 pp. Softcover. ISBN 3-211-83693-4. $79.95.

This book outlines special approaches using singular and non-singular, multi-domain and meshless BEM formulations, hybrid- and reciprocity-based FEM for the solution of linear and nonlinear problems of solid and fluid mechanics and for the acoustic fluid-structure interaction. Use of Trefftz functions and other regularization approaches to boundary integral equations (BIE), boundary contour and boundary node solution of BIE, sensitivity analysis, shape optimization, error analysis and adaptivity, stress and displacement derivatives in nonlinear problems smoothing using Trefftz polynomials, and other special numerical approaches are included. Applications to problems such as noise radiation from rolling bodies, acoustic radiation in closed and infinite domains, 3D dynamic piezoelectricity, Stefan problems, and coupled problems are also included.

Computational Partial Differential Equations: Numerical Methods and Diffpack Programming, Second Edition. - HP Langtangen *(Simula Res Lab, Martin Linges vei 17, Fornebu, PO Box 134, Lysaker, 1325, Norway)*. Springer-Verlag, Berlin. 2003. 855 pp. ISBN 3-540-43416-X. $69.95. (Under review)

Finite Element Methods with B-Splines. - K Hollig *(Universitat Stuttgart, Stuttgart, Germany)*. SIAM, Philadelphia. 2003. 145 pp. ISBN 0-89871-533-4. $65.00. (Under review)

II. DYNAMICS & VIBRATION

9R7. Aeroacoustic Measurements. - Edited by TJ Mueller *(Dept of Aero and Mech Eng, Univ of Notre Dame, 112 Hessert Center, Notre Dame IN 46556-5684)*. Springer-Verlag, Berlin. 2002. 313 pp. ISBN 3-540-41757-5. $99.00.

Reviewed by MG Prasad (Dept of Mech Eng, Stevens Inst of Tech, Hoboken NJ 07030).

It is well known that experimental work plays an important role in acoustics. In particular, the acoustical measurements in the presence of airflow is challenging due to test conditions. This book deals with this challenging and important topic in acoustics namely aeroacoustics. The five chapters of the book deal with various aspects aeroacoustic measurements with applications.

Chapter 1, on ‘‘Microphone measurements in and out of air stream,’’ deals with the acoustic characteristics of wind tunnels. The discussions include criteria for simulation of aeroacoustic test environment with requirements such as propagation effect, scaling, low background noise levels, etc. Chapter 2 presents ‘‘Beam forming in acoustic testing.’’ The use of beam forming technique and its applications in the modeling of wind tunnel noise with non-acoustic hard walls and free jets are discussed. Several beam forming algorithms with techniques for removing interference is discussed in this chapter.

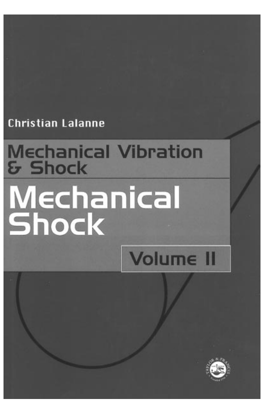
Chapter 3 covers ‘‘Aeroacoustic phased array testing in low speed wind tunnels.’’ A comprehensive treatment of the design and application of acoustic phased array measurement capability for low speed wind tunnels is presented. Various aspects of operation such as calibration, data handling, etc, are discussed. Chapter 4 is on ‘‘Source characterization by correlation techniques.’’ The characterization of acoustical sources using correlation techniques is presented. The chapter discusses various mathematical aspects through cross-correlation and coherence functions. Various examples including correlation measurements between surface pressure and far field acoustic pressure field data are included. The last chapter is ''An anechoic facility for basic aeroacoustic research.'' The chapter presents the design, construction, and performance evaluation of an anechoic wind tunnel facility for low speed and low turbulence applications. Use of such a facility to experimentally investigate fluid-solid interaction is discussed. A specific wind tunnel facility is described. As an example the use of the facility for a marine propeller response to inflow disturbance is discussed.

All chapters are well presented. In summary, *Aeroacoustic Measurements* is a nice integration of presentations of various recognized contributors. The book deals with important issues in design and performance evaluation of wind tunnel test facilities, measurement techniques, and mathematical aspects. Nice photographs and figures are included. Each chapter has a large number of references. The book is recommended for libraries and all graduate students, researchers, and professionals in acoustics. In particular, those involved in experimental aeroacoustics will find this book very useful.

9R8. Mechanical Shock. Mechanical Vibration and Shock Series, Vol II. - C Lalanne *(French Atomic Energy Authority, France).* Hermes Sci Publ, Paris. Distributed in USA by Taylor & Francis Publ, New York NY. 2002. 320 pp. ISBN 1-56032-986-6. $150.00.

Reviewed by C Cetinkaya (Dept of Mech and Aeronaut Eng, Clarkson Univ, CAMP 241, Box 5725, Potsdam NY 13699-5725).

The title under review is the English translation of the original volume published in French in 1999. The work covered appears to be based on the author's professional experience in the French Atomic Energy Authority as a vibration and shock specialist and test specifications developer. This title is the second volume of the author's five-volume set entitled *Mechanical Vibration and Shock*. The other volumes cover harmonic excitations, random vibrations, fatigue, and test specification development.



Protecting the human, structures, material, etc, from impact loading conditions has been an essential concern for designers and engineers in modern applications in which operational speeds and power have been steadily increasing. The title under review covers various well-established shock engineering techniques from mathematical analysis to test specification generation for practical use. Compared to other available titles, such as *Optimal Protection from Impact, Shock, and Vibration* by DV Balandin, NN Bolotnik, and WD Pilkey, the current title is set out to address more practical aspects of the effects of impact and shock testing. In this reviewer's opinion, its main audience will be experimentalist, practicing engineers and technicians working in the areas of impact protection and safety. The primary objective of the book is to assist technical professionals to develop impact (shock) test specifications, qualification and certification documents.

The book consists of nine chapters. Most chapters begin with a number of concise definitions of the concepts used in the rest of the chapter. While many of these definitions are useful, some would differ slightly from some commonly used definitions used in many English books. Perhaps, every translation book suffers from this minor terminology shift. For example, in 1.1.4 the following is given as a definition for *bump*: ''a bump is a simple shock which is generally repeated many times in testing.'' This concept appears to be close to ''pulse'' or ''waveform.'' Another example on terminology is the usage of the word *digitization* in the book for discretization of a function in time (*sampling*). Introductions are typically brief. Each chapter contains a generous number of plots. While the plots are not as polished as those in high-volume textbooks, they are adequate and useful in clarifying the materials. Listings of a few computer codes developed in BASIC programming language are also contained. However, no CD or diskette comes with the book, so the reader who is interested in running numerical simulations is expected to type these programs in.

The book is concerned strictly with linear and discrete systems. Most of the systems considered are low degree-of-freedom (dof) while some multi-dofs are occasionally used. Virtually all the analysis is based on the Fourier transform of ordinary differential equations modeling system dynamics. A college-level calculus background should be sufficient to follow the derivations and analyses presented in the book.

Chapter 1, entitled Shock Analysis, solely focuses on how the frequency spectra of temporal functions are obtained using Fourier transform and sampling theory (based on the fast Fourier transform algorithm). This is a brief, yet useful overview. In Chapter 2, the frequency responses of spring-mass-dampers systems are discussed in detail. The time and frequency responses of single- and multi-dof under various-''standard'' dynamic loading conditions are listed. These standard loading conditions are later used in the development of test specifications. Numerical algorithms for calculating system responses are provided. A program developed in BASIC for shock response spectrum of a single-dof is included. Chapter 3 is devoted to shock response of a system at three different frequency ranges: low frequency (*static domain*), intermediate frequency, and high frequency (*impulse domain*). Amplitudes of responses of systems in these ranges are discussed and various practical relationships are derived and analyzed. Many examples illustrating the uses of these relationships are provided. This is the most mathematical of all the chapters in the book.

Development of detailed shock testing and measurement specifications for practical use is the main theme of Chapter 4. Various simplification and idealization methods for the impact loading conditions used in the development of test specifications have been discussed in great detail. The role of *shock*, *amplitude*, and *duration* choices in simplifying and representation of the waveforms in testing processes is discussed with many examples. Various simulation techniques are introduced and discussed.

Chapter 5 is a brief chapter focusing on kinematics of the shock excitation forms. The shocks are defined as applied acceleration, velocity, and displacement to an elastic system. Pulse shapes such as half-sine, rectangular, and peak saw are considered with various cases of rebounds. These concepts serve as background for the discussions in the following chapters. Standard shock machines are discussed in Chapter 6. A review of the testing systems utilized in practice is provided. The coverage of the programmers generating desired excitation acceleration profiles is particularly interesting. While a minimal amount of actual experimental data is included in the chapter, the descriptions of test machines and programmers are rather clear. The commercially available MTS test machines and programmers have been covered in somewhat detail. Another useful feature of Chapter 6 is that a number of examples are included. Compared to the shock machines covered in Chapter 6, with electrodynamics exciter known as shakers, more versatile excitation profiles can be generated with better reproducibility of impact. Chapter 7 offers a detailed comparison of shakers with other shock generation methods. In Chapter 8, a brief coverage of damage-based shocks generated by explosive charges is provided with various comparisons.

The final chapter of the book is devoted to the control of shakers to generate particular types of excitations with pre-set shock re sponse spectra. The shock profiles obtainedwith the use of simple drop tests (covered in Chapter 6) are typically insufficient to recreate many practical impact conditions for testing purposes. Actively controlled shakers using analog and digital methods are discussed. Plots provided for various excitation waveforms functions (such as ZERD and WAVESIN) could be particularly useful in selecting an appropriate waveform for an application. In addition to an appendix on dimensional scaling in experimental simulations, a brief history on the development of mechanical test machines has been provided with the book.

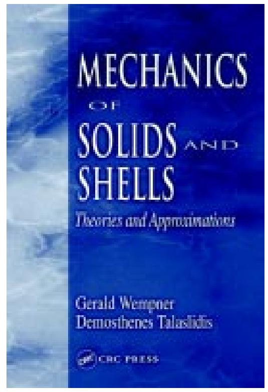
Considering the content and depth of *Mechanical Shock*, practicing engineers and technicians who work in testing and test specification development areas will find this book particularly useful. Also, students and researchers looking for a concise introduction to the field of established impact and shock testing methods would apply practical techniques covered in the book to their specific impact problems. Some readers might find the references to French impact codes particularly interesting. This title can also be used as a quick reference in research laboratories, machines shops, and workshops.

9R9. Mechanics of Solids and Shells: Theories and Approximations. - G Wempner *(Georgia Inst of Tech, Atlanta GA)* and D Talaslidis *(Aristotle Univ, Thessaloniki, Greece)*. CRC Press LLC, Boca Raton FL. 2003. 529 pp. ISBN 0-8493-9654-9. $119.95.

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

This book can be considered a revised and updated edition of the first author's book *Mechanics of Solids with Applications to Thin Bodies*, which was originally published in 1973. Readers who are familiar with this book will find that much of it has been retained, usually verbatim, in the book under review. The main differences are a slight rearrangement of the material, a new chapter on finite elements, and disappointedly, the deletion of the exercises. This latter change, which diminishes the usefulness of the book as a teaching text, is difficult to understand.

The book is suitable for senior undergraduate or postgraduate students and aims to provide a broad foundation of the fundamentals of stress analysis for solids. Much of the text makes significant use of general tensor analysis, and this is briefly covered in Chapters 1 and 2. The book uses component tensor notation, rather than direct ten-sor notation.



Chapters 3–5 cover the fundamentals of continuum mechanics. Chapter 3 discusses the geometry of deformation and the various notions of strain. It also covers the transformations and decompositions of the strain tensor, and the simplifications that can be used under certain conditions, such as for the case of small strains. Chapter 4 introduces the stress tensor and its properties. The two concepts are linked in a lengthy Chapter 5 on constitutive relationships, including elastic and plastic effects.

The energy principles of solid mechanics are discussed in Chapter 6. Virtual work is used as a starting point for deriving the various variational principles and their applications. This chapter also includes a brief discussion on stability theory. Chapter 7 simplifies the general formulation to linear behavior, and discusses some representative problems in two-dimensions. These include plane stress and plane strain problems, stress concentration and torsion theory.

Chapter 8 develops the differential geometry of a surface theory, and this acts as a prelude to Chapter 9 on shell theory. The latter chapter provides a concise presentation of the theory and the role of approximations. The development is continued in Chapter 10, which introduces the Kirchhoff-Love constraint and its implications. The final chapter provides a brief introduction to the finite element method.

Judged on its own merits, *Mechanics of Solids and Shells: Theories and Approximations* is a useful introduction to the field, and it can also serve as a reference for practicing engineers and researchers in the area. As mentioned previously, the lack of exercises makes it more difficult to use as a teaching text, and it would need to be supplemented if used in this role.

9R10. Vehicle Crash Mechanics. - M Huang *(Dearborn MI)*. CRC Press LLC, Boca Raton FL. 2002. 481 pp. ISBN 0-8493-0104-1. $99.95.

Reviewed by N Jones (Dept of Mech Eng, Univ of Liverpool, Brownlow Hill, Liverpool, L69 3GH, UK).

This book has grown out of lectures which have been given by the author on vehicle crashworthiness to automotive engineers from the Ford Motor Company, full service suppliers to the Ford Motor Company, and engineers from various consulting firms. The character of the book reflects this background; it is a thorough and detailed exposition of the subject, which is a cross between a textbook and a handbook. The book focuses almost exclusively on automobiles, although the basic equations, and some of the sections, could also be used for other vehicle crash mechanics.

The book contains seven chapters with the headings: Crash pulse and kinematics; crash pulse characterization; crash pulse prediction by convolution method; basics of impact and excitation modeling; response prediction by numerical methods; impulse, momentum and energy; and crash severity and reconstruction. The chapter on numerical methods focuses on lumped parameter methods, which bring out some of the basic features and response characteristics of vehicle crash mechanics. This would be likely to be more difficult to achieve with finite-element methods of analysis, which are not considered in this book.

Almost all of the references cited are books, SAE papers, or conference proceedings, with virtually no journal articles. This forms a valuable entrée into the literature available on car crash mechanics. English units are used throughout the book, with a page of unit conversions before the index.

Vehicle Crash Mechanics is essential reading for anyone working on, or contemplating studying, the collision mechanics of automobiles. It would also be of value to others with an interest in basic aspects of the crashworthiness of other vehicles (buses, trains, trucks). Some of the sections on the crash pulse analysis would be of interest to many experimentalists who are active in the impact field.

9N11. System Dynamics and Long-Term Behavior of Railway Vehicles, Track and Subgrade. Series Lecture Notes in Applied Mechanics, Vol 6. - Edited by K Popp *(Univ of Hannover, Germany)* and W Schiehlen *(Univ of Stuttgart, Germany)*. Springer-Verlag, New York. 2003. 490 pp. ISBN 3-540-43892-0. $169.00.

New technologies for high-speed railway vehicles have been developed during the last few decades. The primary goals have been to increase traction, axle load, and traveling speed, and to guarantee passenger safety. However, new developments have revealed new limitations: settlement and destruction of the ballast and the subgrade lead to deterioration of the track; irregular wear of the wheels causes an increase in overall load and deterioration of passengers comfort; and damage of the running surfaces of the rail and the wheel is becoming more frequent. These problems have been investigated. This book contains the scientific results of the program as presented at a colloquium on the subject held at University of Stuttgart, Germany, 2002.

Modern Approach to Classical Mechanics. - H Iro *(Inst for Theor Phys, Johannes Kepler Univ, Linz, Austria)*. World Sci Publ, Singapore. Distributed in USA by World Sci Publ, River Edge NJ. 2002. 442 pp. ISBN 981-238-213-5. $58.00. (Under review)

III. AUTOMATIC CONTROL

CMOS Cantilever Sensor Systems: Atomic Force Microscopy and Gas Sensing Applications. - D Lange *(Dept of Elec Eng, Stanford Univ, CIS 205-x, Stanford CA 94305-4075)*, O Brand *(Phys Electron Lab, ETH Zurich, ETH Hoenggerberg, HPT-H4.2, Zurich, 8093, Switzerland)*, and H Baltes *(Phys Electron Lab, ETH Zurich, ETH Hoenggerberg, HPT-H6, Zurich, 8093, Switzerland).* Springer-Verlag, Berlin. 2002. 142 pp. ISBN 3-540-43143-8. $64.95. (Under review)

Nonholonomic Mechanics and Control. - AM Bloch *(Dept of Math, Univ of Michigan, Ann Arbor MI 48109-1109).* Springer-Verlag, New York. 2003. 483 pp. ISBN 0-387-95535-6. $69.95. (Under review)

Optimal Control Systems. - DS Naidu *(Idaho State Univ, Pocatello ID).* CRC Press LLC, Boca Raton FL. 2003. 433 pp. ISBN 0-8493-0892-5. $99.95. (Under review)

Underwater Robots: Motion and Force Control of Vehicle-Manipulator Systems. - Springer Tracts in Advanced Robotics, Vol 2. - G Antonelli *(Dipartimento di Automazione, Elettromagnetismo, Ingegneria dell'Informazione e Matematica Industriale, Univ degli Studi di Cassino, Via di Biasio 43, Cassino, 03043, Italy).* Springer-Verlag, Berlin. 2003. 183 pp. ISBN 3-540-00054-2. $89.95. (Under review)

IV. MECHANICS OF SOLIDS

9R12. Creep Mechanics. - J Betten *(Dept of Math Models in Mat Sci, Tech Univ Aachen, Augustinerbach 4-22, Aachen, 52064, Germany).* Springer-Verlag, Berlin. 2002. 327 pp. ISBN 3-540-42981-6. $89.95.

Reviewed by NCM Tsang (Dept of Civil and Env Eng, Imperial Col of Sci, Tech and Med, London, SW7 2BU, UK).

This textbook covers both the fundamentals and application of mathematical modeling of material behavior under creep conditions using tensor function theory. The book is based on the author's lectures and research publications since 1969. In addition to solid mechanics, the book also covers the analysis of linear and nonlinear viscous fluids. An example of creep damage analysis of thick-walled tubes is provided. The book's level is directed as a text for graduate students and as a reference for professional practitioners and researchers in the area of time-dependent structural stress and deformation analysis.

The book consists of 13 chapters and two appendices. Current advancement in the area of creep and creep rupture is first reviewed among a broader theme of damage mechanics. A description of the tensor function theory and its general bases are given in Chapter 2. This enables the readers to get a grip on the mathematics adopted throughout the book. The basics of the continuum mechanics are presented in Chapter 3. This provides a framework of basic equations for material modeling and demonstrates the need of additional equations to characterize the time-dependent behavior of particular material. These three chapters introduce the fundamental knowledge that is required to study the rest of the book. The chapters should be particularly helpful to postgraduate students.

In Chapter 4, basic modeling techniques of creep behavior in primary, secondary, and tertiary stages are explained. The creep potential hypothesis is presented. A case study on creep behavior of thick-walled tubes is discussed in Chapter 5. The creep potential hypothesis is compared with the tensor function theory in Chapter 6. The variations in modeling isotropic and anisotropic material are discussed. Chapter 7 deals with creep damage and the use of damage tensors. Tensorial generalization of uniaxial creep laws to multiaxial states of stress is illustrated in Chapter 8.

The book then goes on to discuss viscous fluids: linear and nonlinear in Chapters 9–12. Particular attention is given to various viscoelastic rheological models including Maxwell, Kelvin, and Burgers models in Chapter 11. Here, the MAPLE computer program codes of various functions and their results are illustrated. The parametric studies using the MAPLE computer program demonstrate the sensitivities of various parameters of the proposed numerical models. This strengthens the readers' understanding of and confidence in using the models. Viscoplastic materials are briefly explained in Chapter 12. The discussion of creep experiments in Chapter 13 is interesting, and the references of various creep tests are especially useful for researchers. The two appendices detailing the Dirac and Heaviside functions (Appendix A) and Laplace transformations (Appendix B) provide a very useful reference for readers who are not equipped with this type of mathematical skill for creep analysis.

Derivatives for numerical models and algorithms for numerical methods are presented in a very clear manner. This is particularly helpful in clarifying many issues that are presented in an abstract form in other books. The generalization techniques of uniaxial creep laws to handle multiaxial stress states and the highlight of differences in modeling isotropic and anisotropic materials are essential for engineers analyzing modern structures. The figures (72 in total) are clear and of great help in promoting the readers' understanding. Although only one major example covering thick-wall tubes is given, it is adequate in promoting the understanding of this complex modeling technique. For students, the appendices detailing the Dirac and Heaviside functions and Laplace transformations are particularly useful. In conclusion, the style is clear and to the point.

This reviewer enjoyed reading *Creep Mechanics* and recommends it for research students and practitioners alike.

9R13. Process Modeling in Composites Manufacturing. - SG Advani *(Univ of Delaware, Newark DE)* and EM Sozer *(Koc Univ, Istanbul, Turkey).* Marcel Dekker, New York. 2003. 436 pp. ISBN 0-8247-0860-1. $175.00.

Reviewed by L Mishnaevsky Jr (MPA, Univ of Stuttgart, Pfaffenwaldring 32, Stuttgart, D-70569, Germany).

This textbook introduces the reader to the concepts and methods of the modeling of polymer composite manufacturing processes on the basis of the fundamental principles of fluid mechanics, heat transfer, theory, and the analysis of the physics of the process. The authors are successful in their aim to create a self-contained text, which systematically demonstrates "how one would go about modeling a composite manufacturing process."

The book is logically divided into three major parts: introduction to the polymer composite materials and manufacturing processes (Ch 1 and 2), theoretical tools and approaches needed to model the processes (Ch 3–5), and the applications of the models to several manufacturing technologies (Chapters 6–8).

The microstructures and classifications of polymer matrix composites, properties of polymer matrices (thermoplastic and thermoset resines), and fibers, are discussed in the Introduction.

In Chapter 2, Overview of Manufacturing Process, different composites manufacturing techniques are outlined. The manufacturing methods are classified according to the dominant flow processes: short fiber suspension manufacturing methods (processes which involve the transport of fibers and resin as a suspension into a mold or through a die to form a composite; examples: injection and compression molding, extrusion), squeeze flow manufacturing methods (in which the fibers and resin deform together to form a composite shape), and porous media manufacturing methods (in which the resin impregnate and displace the air in a continuous fiber network).

In Chapter 3, Transport Equations for Composite Processing, the basics of fluid mechanics and heat transfer are reviewed. The conservation equations of mass, momentum and energy, stress-strain rate relationships, and their application to modeling the resin flow in the presence of fibers are discussed. Many examples with solutions are included in this chapter.

In Chapter 4, Constitutive Law and Their Characterization, constitutive equations of resins for different cases are discussed. Physical meaning, mechanisms, and temperature dependence of the viscosity of resins, as well as the effect of bundles of aligned fibers and the short fibers on the mechanical behavior of resin are explained.

Modeling of the curing of the resin (kinetics of the reaction of forming 3D network from mono- or oligomers), techniques to monitor cure at macro- and microlevel, and the effect of reinforcement on the curing are described. Then, the authors discuss the mechanisms and the effects of the kinetics of crystallization of thermoplastics during solidification. The permeability concept, which serves as a basis for the analysis of the flow behavior of resin as it impregnates the preform, is described in this chapter as well.

Chapter 5, Model Simplifications and Solutions, deals with the techniques of modeling the manufacturing processes on the basis of the physical laws and concepts described in the previous chapter. Several techniques and approaches, which can be useful in formulation of a model and finding a solution, are described: dimensional analysis, commonly accepted assumptions for polymer composites processing (like quasi-steady state assumption, lubrication approximation, this shell approximation), possible simplifications of boundary conditions and geometry, some mathematical techniques (like coordinate transformations, superposition of solutions, decoupling of equations).

In Chapters 6 (Short Fiber Composites), 7 (Advanced Thermoplastic Composite Manufacturing Processes), and 8 (Processing Advanced Thermoset Fiber Composites), models of technological processes of the composite manufacturing, based on the ideas and principles given in Chapters 3–5 and grouped according to the classification from Chapter 2, are presented and discussed. Models of flow and heat transfer in the compression molding, a method of screw design in the extrusion process and a model of filling stage in injection molding (Ch 6), a model for consolidation and void reduction during the processing of thermoplastic composites, which is based on the consideration of a squeeze flow of a compressible viscous fluid (Ch 7), and the processes of autoclave molding, liquid composite molding and filament molding (Ch 8) are covered.

The book is addressed to seniors and first-year graduate students in materials science and engineering, industrial, mechanical, and chemical engineering, and can also be very useful to specialists in composite manufacturing and modeling, working both in industry and in academia. The book is well structured, and all of the concepts, ideas, and solutions are explained clearly and with many examples and illustrations. Each chapter contains questions and example problems, fill-in-blanks sections, and original figures. The layout of the book is pleasant, and a subject index is available.

Process Modeling in Composites Manufacturing is a very good and useful book, and can be highly recommended to students, scientists, and specialists in modeling and manufacturing of composites and to libraries.

9R14. Scaling of Structural Strength. - ZP Bazant *(Dept of Civil Eng and Mat Sci, Northwestern University, Evanston IL 60201).* Hermes Sci Publ, Paris. Distributed in USA by Taylor & Francis Publ, New York NY. 2002. 280 pp. ISBN 1-56032-984-X. $95.00.

Reviewed by G Lewis (Dept of Mech Eng, Univ of Memphis, 316 Eng Bldg, Memphis TN 38152).

It is widely acknowledged that the subject of scaling or size effects (particularly, in components and structures fabricated from quasi-brittle materials) is, arguably, one of the most important ones in solid mechanics. This is because, from a theoretical perspective, the analysis is very complex, even abstruse, in places. In practical terms, scaling has far-reaching implications for both the design and the cost of prototypes of these components and structures, ranging from reinforced concrete columns on highways and fine crystal wine glasses to silicon nitride machining tool inserts and ice sculptures. It is against this background that this book will be judged; that is, first, the extent to which the author succeeds in mapping out all the theoretical concepts that are relevant to scaling and, second, the extent to which the material covered in the book can aid structural designers. How the book fares on these scores will be discussed following the descriptions of its contents, which are organized into 11 chapters.

In Chapter 1 (*Introduction*), the author provides a sweeping summary of the field of scaling, beginning with two statements that are both catchy and tone-setting; namely, that scaling is central to all physical systems, and that an understanding of any theory describing any physical system exists only when scaling of that system is understood. The author then goes on to make comments about the nature of the problem and to present a brief review of the history of scaling (starting with Leonardo da Vinci's observation about the relationship between the length and strength of cords, continuing with the development of the Weibull theory, and ending with some recent developments in quasi-brittle materials, as exemplified by work on concrete). In this chapter, the three basic theories of scaling in solid mechanics and the four indirect size effects are summarized, and a host of other topics are covered, namely, power scaling in the absence of a characteristic length, transitional size effect bridging power laws for different scales, and deductions of the size effect from dimensional analysis (by, for example, converting the mathematical formulation of the boundary value problem to dimensionless form), and stability of structures and the size effect (for example, in the case of beams, the difference in size effect under elastic buckling conditions compared to when they are on an elastic foundation).

Among the topics covered in Chapter 2 (*Asymptotic analysis of size effect*), are asymptotic analysis of size effect in structures with notches or large cracks (including a comparison of large- and small-size asymptotic expansions of the size effect), energistic size effect law and its asymptotic matching character (including the role of the brittleness number in linear elastic fracture mechanics, LEFM, scaling), use of Rice's J-integral for asymptotic scaling analysis, identification of fracture parameters from size effect tests on concrete specimens, comparison of size effect law (as obtained from tests conducted on Indiana limestone, carbon-epoxy fiber composite, silicon oxide, and sea ice specimens), an examination of whether a universal size effect law exists (that is, the extent to which all expansions, such as the large-size expansion for short cracks, could be made to yield a single expression that matches all the asymptotic cases), interaction diagram (or failure envelope) for the case of many loads, and size effect on approach to zero size (including discussion of two physically meaningful boundary value problems of elasticity for a body with a crack).

As the title of Chapter 3 (*Randomness and disorder*) implies, relevant statistical concepts are described. The chapter opens with a summary of the tenets of the Weibull theory and a presentation of what the author calls ‘‘serious objections’’ (seven, in all) to the applicability of the Weibull theory to quasi-brittle structures. Following this are treatments of a number of relevant topics, such as nonlocal probabilistic theory of size effect, energistic-statistical formula for size effect for failures at crack initiation, and the size effect ensuing from J-integral for randomly located cracks. The chapter ends with detailed critical examinations of the roles of fracture fracticality and lacunar fracticality of microcracks in size effect.

In Chapter 4 (*Energetic scaling for sea ice and concrete structures*), a wide range of topics is covered, these being scaling of the fracture of floating sea ice plates (among the topics covered are thermal bending fracture, numerical simulation and approximate analytical solution of vertical penetration, and the force applied by moving ice on a fixed structure), size effect of softening in beams and plates, steel-concrete beams and the compound size effect, size effect provisions in Japan Concrete Institute, CEB (European), DIN (German), and ACI (United States) design codes, six reasons why use of an excessive dead load factor as a substitute for size effect, in a design code, is inadequate. The chapter ends with a treatment of no-tension design of concrete structures or rock from the perspective of size effect.

The topics covered in Chapter 5 (*Energetic scaling of compression fracture and further applications to concrete, rock, and* *composites*) are propagation of damage band in components and structures fabricated from these materials (under compressive stress), size effect in reinforced concrete columns, the fracturing truss (strut-and-tie) model for shear failure of reinforced concrete beams, experimental and analytical results for the breakout of boreholes in rocks, asymptotic equivalent LEFM analysis for cracks with residual bridging stress, and the applicability of compression kink bands and the effect of orthotropy, in the case of in fiber-reinforced composite materials.

In Chapter 6 (*Scaling via J-integral, with application to kink bands in fiber composites*), the author presents very useful summaries of the following topics: J-integral analysis of size effect on kink band failures (in, for example, single-edge notched carbon fiber-reinforced PEEK test specimens), calculations of the first and second parts of Rice's J-integral, the derivation of an expression for the nominal strength of a specimen that contains a long kink band, failure of notched specimens containing kink bands, and comparison of the results of size effect tests of kink band failures in quasi-isotropic and orthotropic carbon fiber-reinforced PEEK laminates.

The material in Chapter 7 (*Time dependence, repeated loads and energy absorption capacity*) is presented in a summarized manner. The topics covered are the impact of the two causes of fracture growth in materials (the viscoelasticity of the material, in the case of polymers, and the time dependence of the bond ruptures that cause fracture, in, for example, rocks) on the scaling of fracture, the need to correct fatigue crack growth test results for specimen size effect, the viscosity-induced size effect, the relationship between ductility of a structure and its energy absorption capacity, and the influence of size effect on structural ductility.

Among the topics covered in Chapter 8 (*Computational approaches to quasibrittle fracture and its scaling*) are the use of eigenvalue analysis for calculating the size effect (when the cohesive, or fictitious, crack model is used), microplane constitutive model, basic features of the suite of numerical methods which may be used in the simulation of damage localization, fracture propagation size effect (for example, R-curve, finite element analysis, FEA, and element-free Galerkin models), nonlocal damage models, and two key steps to be taken, when performing FEA, to avoid the problems of spurious localization of the damage front into a band of vanishing width and spurious mesh sensitivity of solutions.

The focus in Chapter 9 (*New asymptotic scaling analysis of cohesive crack model and smeared-tip method*) is the extent to which analysis of asymptotic scaling properties of the cohesive crack model is informed by a new variant of the smeared-tip approach (the "K-version"). The chapter begins with a summarized account of the history of both the cohesive crack model and the smeared-tip method. Then, the limitations of the cohesive crack model are detailed. Following this, the application of the K version method to asymptotic scaling analysis for four cases is described. These cases are positive geometry with notch or stress-free initial crack, for fixed K-density (Case 1), fracture initiation from a smooth surface, for fixed K-density (Case 2), Cases 1 and 2 for standard cohesive crack model or first three terms of asymptotic expansion (Case 3), and negative-positive geometry transition (Case 4). Also covered in this chapter are small-size asymptotics of the cohesive crack model; scaling of cohesive fracture (using the nonlocal LEFM approach), the use of the Dirichlet series expansion in a broad-range size effect law, (for Case 1, as given above), and the size effect law in both small- and large-size asymptotics. The chapter ends with a very useful summary of the main points (11, in all) covered in the chapter.

In Chapter 10 (*Size effect at continuum limit on approach to atomic lattice scale*), a number of concepts on scaling that are based, essentially, on microscaling the role of plasticity in the theory of metal plasticity, are covered, among which are the definition of corresponding nominal stresses, an approximate asymptotic-matching formula for the dependence of nominal stress on size (from which the transitional size is estimated), and micro-torsion and Rockwell micro-hardness tests and results.

In Chapter 11 (*Future perspectives*), the author reminds the reader that, although much is now known about damage mechanics, there is a vast expanse of unknowns, and, in an effort to close this knowledge gap, he identifies 13 areas for future research, including the micromechanical basis of softening damage, scaling problems in geophysics, and the mixture of extreme value statistics and the scaling of loads, for a given extremely low probability of failure.

This book has a number of several attractive features. The synthesis of research findings from a large array of studies (the bibliography comprises some 600 titles!), spanning several decades, is impressive. However, one should point out that many of the more recent citations are articles by the author and his collaborators. The reading of the book is greatly facilitated by the fact that, in each chapter, the material is assembled into many sections and subsections. The equations presented were selected judiciously to enhance understanding of the underlying concepts. In all cases, modifications of the quoted equations are set out very carefully. The potential for the use of scaling effect in emerging areas, notably components and structures engineered using nanotechnology techniques, is acknowledged through a very impressive coverage, in Chapter 10, of continuum mechanics at the atomic lattice scale. Throughout the book, the writing is consistently lucid and well paced (expansive, where appropriate, and economical in other places). The physical layout of the book is aesthetic; in particular, the diagrams are well drawn and fully annotated.

Regrettably, the book does have three major flaws and one minor one. The first major flaw is that size effect in metallic structures is not covered at all. (The author's rejoinder may be that the focus of the book is the analysis of size effect in components and structures fabricated from quasi-brittle materials, for which the effect is both acute and complicated. However, this path of defense, if it is taken, may be insufficient given the title of the book and the fact that the limit of the coverage to the aforementioned materials is not explained explicitly in the Introduction chapter. Furthermore, there are many cases of practical importance of ductile materials that undergo transformation to brittleness under certain environmental conditions; vide the ductile-brittle transition phenomenon in mild steel.) The second main flaw is that only in a few sections (such as that dealing with size effect tests of kink band failures in carbon fiber-reinforced epoxy laminates) does the author present and comment on comparisons between experimental and theoretical results. Other than in Chapter 9, there are no succinct summaries of the main points of the material covered in the chapter. Such summaries would have been very useful given the denseness of the material in nearly all chapters.

All things considered, the author is to be congratulated on having written a first-class text on a most important (but, sadly, either neglected or misunderstood) subject. Given the topics covered and the method of treatment, the audience for this book is more likely to be graduate students and researchers in structural mechanics than structural designers. The present reviewer most warmly recommends *Scaling of Structural Strength* to the former group.

9N15. ASM Handbook, Volume 11: Failure Analysis and Prevention. - Edited by RJ Shipley and WT Becker. ASM Int, Materials Park OH. 2002. 950 pp. ISBN 0-87170-704-7. $206.00.

This new Volume 11, with a focus on the *root causes* of failure, describes the principles, practices, and analytical techniques of failure analysis, so that root causes are properly identified and corrected for the ultimate objective of failure prevention.

It begins with sections on the general engineering aspects of failure prevention with coverage on fundamental root causes, materials selection, and the role of design reviews in failure prevention and analysis. Additional sections describe failures related to metals manufacturing operations and the increasingly important role of life assessment methods in failure prevention. This is followed by a series of additional sections on the failure analysis process, as well as the principles, practices, tools, and techniques used to perform and evaluate failure analysis work and the causes, mechanisms, appearances, and prevention methodology for the four classic types of failure (fracture, corrosion, wear, distortion).

9N16. Atlas of Stress-Strain Curves, Second Edition. - ASM Int, Materials Park OH. 2002. 850 pp. ISBN 0-87170-739-X. $248.00.

This edition is substantially larger—in page dimensions, number of pages, and total number of curves. It contains more than 1400 curves, almost three times as many as in the 1987 edition. The curves are normalized in appearance to aid making comparisons among materials. All diagrams include metric (SI) units, and many also include US customary units. All curves are captioned in a consistent format with information including standard designation, the primary source of the curve, mechanical properties (including hardening exponent and strength coefficient), condition of sample, strain rate, test temperature, and alloy composition. Curve types include monotonic and cyclic stress-strain, isochronous stress-strain, and tangent modulus.

The book also includes an introduction that provides background information on methods of stress-strain determination, on data presentation and analysis, and on application of the results.

9N17. Composite Materials Handbook-MIL 17. - ASTM, W Conshohocken PA. 2002. 2384 pp. 5-Vol Set includes CD-Rom. $650.00.

This handbook, for the structural applications of composite materials, includes standards for test and characterization methods, statistics, and databases, as well as guidelines for processing, design, analysis, quality control, repair, and material selection. It provides information on polymer matrix, metal matrix, and ceramic matrix composite materials.

9N18. Geosynthetics and their Applications. - Edited by SK Shukla. Thomas Telford Ltd, London. 2002. 416 pp. ISBN 0-7277-3117-3.

Basic definitions and concepts, as well as case histories and information on recent developments in geosynthetics are given. Topics covered include fundamentals of geosynthetics; soil-geosynthetic interaction; retaining walls; embankments; shallow foundations; unpaved roads and paved roads; railway tracks; slopes-erosion control; slopes-stabilization; landfills; earth dams; containment ponds, reservoirs, and canals; geosynthetic reinforced soil walls and slopes, seismic aspects; and geosynthetic applications.

9N19. Guidelines for the Use of Advanced Numerical Analysis. - Edited byD Potts *(Imperial Col),* K Axelsson *(Jonkoping Col),* L Grande *(NTNU Trondheim),* H Schweiger *(Graz Univ),* M Long *(Univ Col Dublin).* Thomas Telford Ltd, London. 2002. 208 pp. Softcover. ISBN 0-7277-3125-4.

This book is an authoritative guide that explains, in detail, the potential restrictions and pitfalls of advanced numerical analyses.

9N20. Inelastic Behavior of Structures Under Varied Repeated Losses: Direct Analysis Methods. - Edited by D Weichert *(RWTH, Aachen, Germany)* and G Maier *(Politecnico di Milano, Italy).* Springer-Verlag, New York. 2003. 403 pp. Softcover. ISBN 3-211-83687-X. $89.95.

Safety assessment is made of structures and structural components, possibly operating beyond the elastic limits under variable repeated thermo-mechanical loads. Examples of such situations can be found both in mechanical and civil engineering (eg, transportation technologies, pressure vessels, pipelines, offshore platforms, dams, pavements, and buildings in seismic zones). So-called *direct* methods are focused, based on the shakedown theorems and their specialization to limit theorems.

9N21. Practical Non-Destructive Testing, 2nd Edition. - Edited by B Raj, T Jaykumar, and M Thavasimuthu. ASM Int, Materials Park OH. 2002. 184 pp. ISBN 0-87170-763-2. $60.00.

This book covers the principles, procedures, applications, selection, and limitations of all widely used nondestructive testing techniques.

9N22. Thermal Properties of Metals. - ASM Int, Materials Park OH. 2002. 300 pp. ISBN 0-87170-768-3. $155.00.

This new volume is a quick and easy-to-use source for qualified thermal properties of metals and alloys. The data tables are arranged by material hierarchy, with summary tables sorted by property value. Values are given for a range of high and low temperatures. Short technical discussions at the beginning of each chapter are designed to refresh the reader's understanding of the properties and units covered in that section.

This reference presents a comprehensive listing of thermal properties of metallic materials. Data was collected from more than 80 sources and includes values for both ferrous and nonferrous metals and alloys. Sources and qualifiers are listed for all values. Values are listed in the preferred (SI) units and alternate (customary) units.

Understanding Viscoelasticity: Basics of Rheology. - N Phan-Thien *(Mech Eng Dept, Natl Univ of Singapore, Singapore, 119260, Singapore).* Springer-Verlag, Berlin. 2002. 145 pp. ISBN 3-540-43395-3. $34.95. (Under review)

V. MECHANICS OF FLUIDS

9R23. Flow Control by Feedback: Stabilization and Mixing. - OM Aamo *(Norwegian Univ of Sci and Tech, Trondheim, N-7491, Norway)* and M Krstic *(Univ of California, San Diego, La Jolla CA 92093-0411).* Springer-Verlag London Ltd, Surrey, UK. 2003. 198 pp. ISBN 1-85233-669-2. $99.00.

Reviewed by W Shyy (Dept of Aerospace Eng, Mech and Eng Sci, Univ of Florida, 231 Aerospace Bldg, PO Box 116250, Gainsville FL 32611-6250).

Flow control is a multidisciplinary topic and, by definition, requires expertise in both fluid dynamics and control theory. Many papers and some books have been published on this topic. However, successful efforts, at least for those amenable to physical implementation, are essentially all based on open-loop practices with no feedback mechanisms. To date, very few concrete examples and little comprehensive framework have been developed for closed-loop control. From this viewpoint, the present book is a welcomed addition in a timely and challenging area.

The book is relatively thin, with 183 pages of text. However, its coverage is rather broad, including summaries of governing equations for fluid dynamics, preliminary concepts of the control theory, and detailed discussion of selected case studies in feedback flow control. Overall, the presentation is uneven. In particular, certain equations and theoretical derivations are given in lengthy details, but with little discussion of their physical implications. An obvious example is the governing equations for fluid dynamics. After devoting Chapter 2, totaling 24 pages, to review the subject, anyone who is not already familiar with fluid dynamics will have gained little improved understanding of the subject. A brief discussion of the meaning, implication, and significance of each term in the governing equations would help. Some of the most critical issues related to fluid dynamics: nonlinearity and associated stability issues, different mathematical characteristics of the equations governing the individual flow variables such as velocity and pressure, and the implications of boundary conditions and geometry should have been given attention, especially in the context of flow control. Furthermore, the lead paragraph in Chapter 4 (Stabilization), which motivates flow control, contains inaccurate or incorrect statements. Similar complaints can be made about Chapter 3, which reviews control theory.

In contrast, Chapters 4 and 5 contain significant and state-of-the-art information. Chapter 4 focuses on stabilization of channel flows and suppression of vortex structures, while Chapter 5 discusses mixing and dispersion. Well-established tools such as the Lyapunov stability analysis and useful models such as the Gingsburg-Landau equation have been presented and fruitfully employed. Nice fluid flow examples based on numerical simulations are offered to demonstrate the implications of the theoretical framework. Some of the detailed presentations of the fluid flow computations also suggest that the resolution of the numerical simulation presented may not be sufficient for certain problems. Computational cost and resolution requirement are main concerns in simulation-based flow control development and can be fruitfully addressed in the book. More interpretation and explanation of the fluid physics associated with the case studies would also substantially strengthen the content. Finally, several important topics are missing, including reduced order representation of the full field simulation data (which is to be differentiated from reduced order model to approximate physical laws), scalability of the control strategies with respect to flow parameters (such as the Reynolds number), and physical implementation of control strategies.

Chapter 6 presents sensors and actuators. Needless to say, it is difficult to do justice within 4.5 pages of the text for such fast developing and diverse topics.

Flow Control by Feedback: Stabilization and Mixing has recorded the experience of two active researchers pursuing theoretical flow control. It is not suitable as a textbook, but can be useful for experienced scholars in need of specialized references.

9R24. Variable Density Fluid Turbulence. Fluid Mechanics and its Applications, Vol 69. **-** P Chassaing *(Inst de Mecanique des Fluides de Toulouse, Toulouse, France),* RA Antonia *(Univ of Newcastle, Newcastle, NSW, Australia),* F Anselmet *(Inst de Recherche sur les Phenomenes* *hors Equilibre, Marseille, France)*, L Joly *(Ecole Natl Superieure d'Ingenieurs de Constructions Aeronautiques, Toulouse, France)*, and S Sarkar *(Dept of Mech and Aerospace Eng, UCSD)*. Kluwer Acad Publ, Dordrecht, Netherlands. 2002. 380 pp. ISBN 1-4020-0671-3. $110.00.

Reviewed by R Verzicco (Dept di Ingegneria Meccanica e Gestionale, Politecnico di Bari, Via Re David 200, Bari, 70125, Italy).

This book attempts to address the topic of variable density fluid turbulence by reviewing several approximations for compressible flow equations, various density induced flow effects, some model homogeneous and free-shear flows, and in the last part, first- and second-order compressible turbulence modeling. The adequate statistical tools are also provided in order to better analyze the variable density turbulent motion.

This monograph is a very valuable addition to the existing literature since, although variable-density turbulence is extremely common in industrial and geophysical applications, its systematic study is very scarce.

The book consists of 11 chapters, a very large list of references, and a subject index. The chapters are gathered into three main parts—theoretical elements, physical analysis, and modeling for industrial applications.

Chapter 1 introduces the topic by a preamble with a motivation for studying compressible turbulence. Some expected density variation effects are then listed and explained. At the end, a summary of each chapter's content, the contributions given by the individual authors, and acknowledgments are given. Chapter 2 gives an overview of variable density effects in turbulent flows. These include stability and transition of mixing layers and jets, buoyancy driven and compressed turbulence, compressible shear flows, shock turbulence interactions, and compressible turbulent boundary layers.

Chapter 3 reviews different approximations of the variable density Navier-Stokes equations including Lighthill's acoustic analogy, Boussinesq approximation, and low-Mach number formulation. The incompressible equations are then derived as the limit of the general equations. In Chapter 4, the equations governing fluid mixtures (with particular emphasis to binary mixtures) are introduced together with the non-dimensional parameters. The dynamics of density fluctuations is then discussed for several kinds of approximations.

Chapter 5 provides the essential tools for variable density flows and derives the transport equations governing averaged and single point properties of the flow field. A detailed comparison of the terms coming from binary and ternary regrouping is performed, and the physical meaning of the arising terms is given.

In Chapter 6, some basic variable density mechanisms of turbulent flows are highlighted. This is achieved by deriving the vorticity equation for a general flow and by evidencing the terms that are absent in incompressible flows. The role of density fluctuations and their diffusive effect are analyzed in low-speed flows. The last part of the chapter is devoted to mechanisms associated with dilatation fluctuations and dissipation terms in relation with their contributions to energy balance equations.

Chapter 7 is very specific, dealing with the behavior of velocity and scalar structure functions in turbulent flows. In particular, the classical Kolmogorov and Obhukov hypotheses and results are critically considered in view of the only moderately high Reynolds number attained in laboratory conditions. This chapter should be regarded as a pedagogical background, since it is only concerned with incompressible flows.

The analysis of the structure of variable density low-speed shear flows is performed in Chapter 8. In particular, mixing layers and jets are considered, and many topics presented in previous chapters are re-introduced from a different perspective.

Chapter 9 presents those free shear flows whose density changes are induced by high velocity values. Once again, mathematical preliminaries are given and the equations are commented. The dynamics of high-speed shear layers with the stabilizing effect of the Mach number, the growth rate of the various thicknesses, and thermodynamic fluctuations are presented.

The last two Chapters, 10 and 11, are devoted to compressible turbulence modeling. Both chapters review the existing models (with zero-, one-, two-equations and for the full Reynolds Stress Tensor) with a particular look at the modifications and additional terms needed to account for density variations.

This monograph has the ambitious goal to describe in a single text all the complex dynamics of variable density turbulence. In some respects, the book is successful since many complex and poorly understood phenomena are illustrated with physical examples and the analysis of the single terms of the equations. What this reviewer has found less successful is the amalgamation of the different chapters, since many topics are discussed more than once using different notations for the equations and terminology.

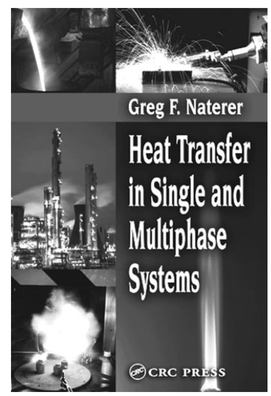
This reviewer has found several misprints in the text and formulas and, even though the quality of the figures is generally good, reproducing color plots using gray levels yields misleading figures. The last two points, however, cannot be ascribed to the authors but rather to the editorial office. In conclusion, this reviewer enjoyed reading *Variable Density Fluid Turbulence* and advises the purchase of the text to graduate students, researchers, and engineers, as well as libraries.

VI. HEAT TRANSFER

9R25. Heat Transfer in Single and Multiphase Systems. - GF Naterer *(Univ of Manitoba, Winnipeg, Manitoba, Canada)*. CRC Press LLC, Boca Raton FL. 2003. 618 pp. ISBN 0-8493-1032-6. $129.95.

Reviewed by Lea-Der Chen (Dept of Mech and Ind Eng, Univ of Iowa, 2416B Seamans Center, Iowa City IA 52242).

It is stated in Preface that a "primary motivation for writing this book comes from discovering the need for a single source of material to cover each mode of multiphase heat transfer, as well as the fundamentals of heat transfer." The author has successfully brought together a broad range of fundamentals of thermodynamics and transport modeling of single-phase and multiphase heat transfer. Application of the second law of thermodynamics to heat transfer analysis is an important aspect of this book. This book has eleven chapters, ten property tables, and one subject index. Each chapter comes with a good mix of "homework" problems of fundamental and applied questions.



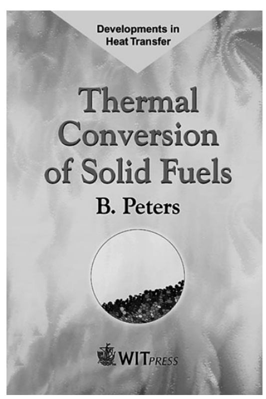
The eleven chapters are introduction, conduction heat transfer, convective heat transfer, radiative heat transfer, phase change heat transfer, gas (vapor)-liquid systems, gas-solid (particles) systems; liquid-solid systems, gas-liquid-solid systems, heat exchangers, and computational heat transfer. Chapter 1 reviews the vector and tensor notations, properties and the first law of thermodynamics, three modes of (single-phase) heat transfer, and phase change heat transfer. Chapters 2–4 cover the three modes of heat transfer. One-dimensional, stated-state heat conduction is emphasized in Chapter 2. Discussion of the transient and multi-dimensional heat conduction is also included. Formulation of two-dimensional convective heat transfer is detailed in Chapter 3. Examples of external and internal flows, forced and free convection are also given, along with a brief account of classical turbulence modeling. Entropy balance equations are introduced. Chapter 4 presents fundamentals of thermal radiation. Radiative heat exchange equations are given for calculation of radiative heat transfer between multiple diffuse and gray surfaces; only non-participating medium is considered. Extensive discussion of solar energy is also given in Chapter 4. Chapter 5 covers the thermodynamics of phase change and transport modeling of solidification and melting, and evaporation and sublimation. The transport modeling is presented within the context of the ‘‘mixture’’ (or volume averaging) and two-fluid formulations. The interfacial equations describing the mass, momentum and energy balances, and the interfacial entropy constraint are also introduced. Chapters 6–9 include extensive discussions on the calculation of heat transfer in gas-liquid, gas/liquid-solid, and gas-liquid-solid systems. Boiling, condensation, and thermosyphon are covered in Chapter 6; particle-laden flow and fluidization in Chapter 7; solidification and melting in Chapter 8; and non-reacting and reacting multi-phase flows in Chapter 9. A simplified approach that accounts for participating (gray) gases and solids is used for calculation of the combined convective and radiative heat transfer in Chapter 7. The applications of liquid-solid analysis to material processing, manufacturing processes, energy storage, and pipeline freezing are given in Chapter 8, and examples of freezing of water drops laden flows (non-reacting), and combustion and metallurgy applications (reacting) in Chapter 9. Heat exchanger calculations using the overall heat transfer coefficient and NTU methods are covered in Chapter 10. An overview of the finite difference and finite element methods for computational heat transfer is given in Chapter 11. Discussions are also given on the finite volume formulation, structure vs unstructured grid, numerical ‘‘formulations’’ of example applications, and numerical accuracy and efficiency.

This reviewer feels that *Heat Transfer in Single and Multiphase Systems* makes a good candidate as a textbook or as a reference for a three-semester hour, intermediate level heat transfer course, of which the course objectives are to cover the three modes of heat transfer and the multiphase heat transfer. This reviewer also recommends this book for libraries of institutions of higher learning, and for personal libraries of heat transfer professionals.

9R26. Thermal Conversion of Solid Fuels. Developments in Heat Transfer, Vol 15. - B Peters *(Res Center Karlsruhe, Karlsruhe, Germany).* WIT Press, Southampton, UK. Distributed in USA by Comput Mech, Billerica MA. 2003. 205 pp. ISBN 1-85312-953-4. $122.00.

Reviewed by SR Gollahalli (Lesch Centennial Chair, Director, Sch of Aerospace and Mech Eng, Univ of Oklahoma, Norman OK 73019-0601).

This monograph deals with the analysis and numerical simulation methods of thermal conversion of solid fuels, which includes various processes of drying, pyrolysis, devolatilization, and gasification. These processes occurring in a packed or moving bed situation include complex and interconnected mechanisms involving thermodynamics, fluid dynamics, chemistry, and physics. An analysis that delineates the relevant processes from the minor mechanisms that led to the development of the Discrete Particle Method (DPM), which considers particles with conversion processes attached to it as an individual entity, is the basis of the book’s contents. Three major areas have been identified in the thermal conversion of solids and addressed individually with simulation methods: heat and mass transfer interaction between solid, liquid, and gaseous phases in a particle; reacting flow in the voids between the particles; and overall motion of an ensemble of particles. The conversion of a particle is described by conservation equations similar to those in computational fluid dynamics, and the motion of the particles is described by molecular dynamics methods under the hierarchy of TOSCA (Tools of object-oriented software for continuum-mechanics applications).



The first chapter presents an overview of the thermal conversion processes of a packed bed including the conversion regimes of a single particle and a packed bed, and ends with an extensive review of the literature on packed bed, particle, and gas phase conversions. The second chapter, on numerical methods, begins with models in the literature on drying, pyrolysis, gasification, and heterogeneous combustion. Thermo-fluid interaction in a reacting packed bed and particle motion are covered in the rest of this chapter. The third chapter, describing the techniques in TOSCA, deals with object-oriented programming. The fourth chapter presents predictions obtained using the TOSCA software library and their validations, and includes single particle conversion, motion of particles, and packed bed conversions, such as a forward acting grate and a combustion chamber. The last chapter presents a concise summary and conclusions. Three appendices covering the list of nomenclature, experiments facilities, and numerics follow the conclusions. An extensive bibliography with 318 references and a subject index are also included.

Overall, *Thermal Conversion of Solid Fuels* contains interesting material on numerical analysis based on a novel technique for analyzing solid thermal conversion processes. Engineers that deal with drying processes, gasification, and packed bed reactors should find this book interesting and useful. It is a valuable addition to the reference libraries for research and academia.

Nonclassical Thermoelastic Problems in Nonlinear Dynamics of Shells. Applications of the Bubnov-Galerkin and Finite Difference Numerical Methods. - J Awrejcewicz *(Dept of Automatics and Biomechanics, Tech Univ of Lodz, 1/15 Stefanowskiego St, Lodz, 90-924, Poland)* and VA Krys’ko *(Dept of Math, Saratov State Tech Univ, 77 Polyteshnycheskaya St, Saratov, 41005, Russia).* Springer-Verlag, Berlin. 2003. 428 pp. ISBN 3-540-43880-7. $89.95. (Under review)

X. GENERAL & MISCELLANEOUS

9N27. Nanotechnology: Basic Science and Emerging Technologies. - M Wilson, K Kannangara, G Smith *(Univ of Tech, Sydney, Australia),* M Simmons *(Atomic Fabrication Facility, Sydney, Australia),* and B Raguse *(CSIRO Telecomms and Indust Phys, Lindfield, Australia).* Chapman and Hall/CRC, Boca Raton FL. 2002. 288 pp. ISBN 1-58488-339-1. $59.95.

This book bridges the gap between detailed technical publications that are beyond the grasp of nonspecialists and popular science books, which may be more science fiction than fact. It provides a fascinating, scientifically sound treatment.

After a basic introduction to the field, the authors explore topics that include molecular nanotechnology, nanomaterials and nanopowders, nanoelectronics, optics and photonics, and nanobiomimetrics. The book concludes with a look at some cutting-edge applications and prophecies for the future.

Author Index for September 2003

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