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.

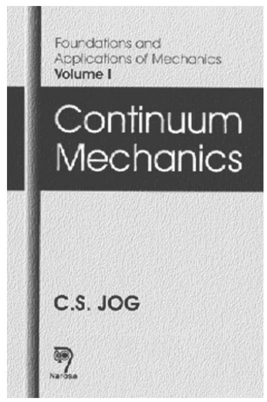
I. FOUNDATIONS & BASIC METHODS

7R1. Foundations and Applications of Mechanics, Volume I: Continuum Mechanics. - CS Jog *(Dept of Mech Eng, Indian Inst of Sci, Bangalore, 560 012, India).* Narosa Publ, New Delhi, India. Distributed in USA by CRC Press LLC, Boca Raton FL. 2002. 254 pp. ISBN 0-8493-2414-9. $89.95.

Reviewed by K Hutter (Dept of Mech, Darmstadt Univ of Tech, Hochschulstr 1, Darmstadt, D-64289, Germany).

This is a formal book on introductory continuum mechanics, written primarily for applied mathematicians and theoretical engineers kept in the style of rational continuum mechanics and consisting of seven chapters. The preface provides a brief descriptive coverage of its content. Chapter 1 gives an introduction into tensors at an intermediate level using symbolic and Cartesian tensor notation interchangingly. The spectral properties of symmetric tensors and their polar decomposition, simple isotropic tensor functions as well as differentiation and integral laws are discussed. The chapter ends with an introduction to groups where the maximality of the orthogonal group in the unimodular group is derived. Chapter 2 is devoted to kinematics; the motion function and its spatial and time derivatives are introduced as are various measures of strain and rates of strain as suggested in the Eulerian and Lagrangian description.

Chapter 3 carries the vague title, "Governing Equations," but is devoted to the conservation laws of mass, linear and angular momenta, and the energy and entropy balances. It also covers a presentation of the properties of the Cauchy stress tensor and introduces into a variational formulation of the mechanical equations. Constitutive relations are dealt with in Chapter 4. Frame indifference is discussed both as invariance under a change of observer as well as one under a superimposed rigid body motion. Simple materials are defined as materials whose stress depends only on the history of the deformation gradient. Material symmetry is discussed in detail, in particular with regard to the characterization of a body being a solid, a fluid, or a fluid crystal. The chapter ends with a presentation of nonlinear and linear elasticity, isotropic and anisotropic, including the energy formulation of a hypoelastic solid.



Chapter 5 is devoted to linear elasticity, its variational formulation, and uniqueness proofs for elastostatic and elastodynamic problems. Chapter 6, devoted to thermodynamics, begins with the derivation of the thermodynamical balance laws of mass and momenta by applying the rules of frame indifference to the first law of thermodynamics. The consequences of the second law of thermodynamics are exclusively dealt with in the context of the Clausius-Duhem inequality and by using the Coleman-Noll approach in exploiting the entropy principle. The constitutive relations for thermoelastic solids and some viscoelastic fluids are reduced to their thermodynamically admissible form and—for the fluid—relations relating caloric and thermal equations of state are presented. The last chapter, 7 is devoted to rigid body dynamics and is seen by this reviewer as being alien to the previous text.

The spirit of the book is formalistic, and the mathematics is clearly presented, but the addressees are more likely theoretically inclined engineers than mathematicians. Books in a similar spirit are those of Chadwick and Gurtin, referenced in this book as [4] and [9], but this reviewer prefers the latter two because they are more thought provoking and less motoric in the development of the concepts. The book can be recommended to upper-level undergraduate and graduate students who wish to learn rational continuum mechanics with a great deal of the demonstration of its technicalities. Problem sets at the end of each chapter support such a desire.

There are, however, also severe weaknesses. In the preface, the author emphasizes the significant role played by Leonhard Euler, and how crucial it is to identify the equations of motion as Euler's achievement and not Newton's; but neither Euler's nor Newton's works are referenced. Quite generally, the reference list is more than indigent, and references to scientists in the text are often not found in the reference list. The concept of frame indifference is introduced in two different ways, which are conceptually different and yield different results in general, but Fig. 4.3 states both to be equivalent; this distinction is not made clear in the text. The concept of simple materials is confusingly, if not incorrectly, introduced. Similarly, Theorem 4.7.4 states the linearized stress strain relation for an elastic body when referred to a stress-free homogeneous reference configuration, but does not explicitly say so. The theorem is therefore misleading. Most severe, however, is the author's handling of the second law of thermodynamics involving the Clausius-Duhem inequality. No mention is made about the role played by the balance laws of mass and momentum when exploiting the entropy inequality. This has been made very clear by the founders of this way of deducing results from the entropy principle. This reviewer cannot see how any student could possibly understand this from the authors approach.

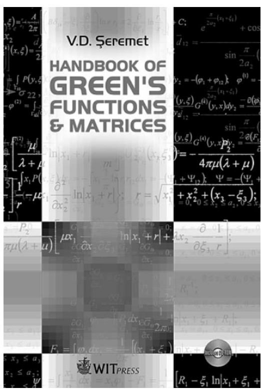
In summary, *Foundations and Applications of Mechanics, Volume I: Continuum Mechanics* can serve as a valuable source for teachers and students of continuum mechanics. It is written in good English and with almost no misprints. It may well be adequate as a class book or for complementary reading.

7R2. Handbook of Green's Functions and Matrices. - VD Seremet *(State Agrarian Univ of Moldova, Rep of Moldova).* WIT Press, Southampton, UK. Distributed in USA by Comput Mech, Billerica MA. 2003. 295 pp. CD-Rom included. ISBN 1-85312-933-X. $229.00.

Reviewed by GC Gaunaurd (Code AMSRL-SE-RU, Army Res Lab, 2800 Powder Mill Rd, Adelphi MD 20783-1197).

This handbook is intended for the specialist interested in the solution of Poisson's equation and the Navier equations of elastostatics (here called the Lamé equations) in a number of particular situations. The handbook comprises a book and a compact disc

(CD). The book has two parts each with two chapters. Part I contains the theoretical part. Part II gives a list of 'Green's functions' for Poisson's equation and a list of 'dyadic Green's functions' (here called Green's matrices) for the Navier equations of elastostatics. (These are not to be confused with the Navier-Stokes equations of Fluid Mechanics, which are time-dependent and nonlinear, since they are expressed in Eulerian coordinate frames.) Part III is a CD that contains six appendices to the book, with numerous practical examples. Appendix I shows how to construct Green's functions for Poisson's equation, and Appendices III and V, the ones for the Navier equations. The other three appendices give examples of cases in which these Green's functions appear in applied problems of mathematical physics.



It is difficult to summarize this book in this brief review and do it justice. The author has done an excellent job. It covers material not well known in the West. As far as this reviewer knows, this book is unique in this respect. These Green's functions are the basic tools needed to solve boundary value problems in elastostatics. Part I introduces the method of "incompressible influence elements." This method leads to a new theory developed by the author for the construction of influence functions for bulk-dilatation and dyadic Green's functions, whose components are the displacement components for boundary-value problems of elastostatics.

Part II implements the theory presented in Part I and constructs the Green's functions of some specific boundary-value problems (BVP). Here is a practical collection of hundreds of problems on Green's functions for these equations. These problems and their answers are presented to the reader for use in practical cases or to practice his own mathematical skills. The derivations are not shown; only the answers are listed. As mentioned above, Part III is the CD. Here many typical 2D and 3D BVPs for Poisson's and Navier equations are solved. Some explanations on how to construct the Green's Function in question are given here.

The book is a collection of Green's functions for two elliptic second-order partial differential equations, and as such, is quite heavy on the math. There are no graphs, and there are also some shortcomings. For example, only the first basic problem of elasticity is addressed, only domains describable in Cartesian coordinate systems are presented, and there are many grammatical errors due to perhaps the fact that the author is not very familiar with the technical terminology in English.

Handbook of Green's Functions and Matrices is quite excellent, and in many respects, unique. Its intended audience is the advanced graduate student, and since there are no derivations, maybe it is intended for the research specialist, who already knows how to derive these results, but wishes to have quick access to them. In other words, it is like a Table of Integrals. Its steep price will undoubtedly restrict its circulation. It is certainly a reference of high value for institutional libraries. This reviewer believes that it would be advantageous if the author would some day extend this work to the elastodynamic (ie, time-dependent) cases governed by the various types of wave-equations and/or the Navier-equations of elastodynamics that govern elastic vibrations. These dynamic situations are more likely to be encountered in practical instances, rather than their static counterparts.

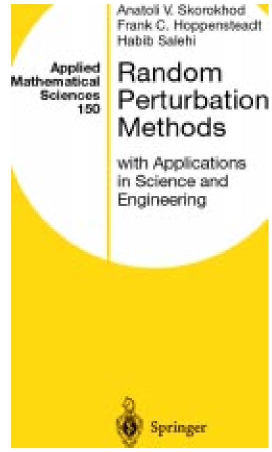
7R3. Random Perturbation Methods with Applications in Science and Engineering. Applied Mathematical Sciences, Vol 150. - AV Skorokhod *(Inst of Math, Ukrainian Acad of Sci, 3 Tereshchenkivska St, Kiev, 01601, Ukraine),* FC Hoppensteadt *(Syst Sci and Eng Res Center, Arizona State Univ, Tempe AZ 85287-7606),* H Salehi *(Dept of Stat and Probab, Michigan State Univ, E Lansing MI 48824).* Springer-Verlag, New York. 2002. 488 pp. ISBN 0-387-95427-9. $79.95.

Reviewed by VD Radulescu (Dept of Math, Univ of Craiova, 13, St AI Cuza, Craiova, 1100, Romania).

The authors attempt to describe the basic methods and general principles of the theory of random perturbation, as well as some of the main applications of this theory in Mechanics, Engineering, Genetics, and Population Biology. This monograph contains a well-written rigorous mathematical treatment of this subject and deals with modern concepts such as dynamical systems, stochastic processes, stability, Markov chains, population biology, etc.

The volume consists of 12 chapters, but the structure of the book is roughly in two parts. The first seven chapters develop several mathematical methods that are useful in the study of random perturbations of dynamical systems. The second part (Chs 8–12) presents nonrandom problems in a variety of important applications.

The purpose of Chapter 1 is to describe some basic ergodic theorems (including Birkhoff's Classical Ergodic Theorem) from a mathematical point of view and to recall some results that will be used in the book. There are also described discrete-time and continuous-time Markov processes, and continuous-time stationary processes.



Chapter 2 is devoted to some convergence properties of stochastic processes. Technical conditions that are sufficient for various kinds of convergence are described. The results contained in this chapter are developed mostly in the framework of continuous-time processes.

In Chapter 3 the authors develop averaging methods for random perturbations of Volterra integral equations, of differential equations and of difference equations. In each of these cases, the remainder term is considered in greater detail in Chapter 4. The main results in this part of the book establish that the deviation tends to zero in a prescribed sense if an averaging theorem is true.

Chapter 5 deals with randomly perturbed systems of differential and difference equations whose averaged systems are static. The main result contained in this chapter establishes that, under some reasonable assumptions, the stochastic process becomes, asymptotically, a diffusion process.

Chapter 6 gives an outlook to a variety of stability problems for differential and difference equations when they are perturbed by random noise. The authors also describe the growth of solutions to certain randomly perturbed convolution equations. The abstract results are illustrated by several examples of stability phenomena.

Chapter 7 deals with Markov chains having a finite state space, but random transition probabilities. The basic hypothesis is that the transition probabilities of the Markov chain are close to those of a homogeneous Markov chain having nonrandom transition probabilities. Under this assumption, the authors establish the asymptotic behavior of the chain and its transition probabilities.

In Chapter 8 it is described a method for studying various kinds of bifurcations for two-dimensional mechanical systems. There are also discussed random perturbations of oscillatory linear systems and of rigid-body motions.

In Chapter 9 the authors consider a dynamical system on a two-dimensional torus. The main results involve either flows that have non random elements or random perturbations of problems of this type.

In Chapter 10 an important electronic circuit, namely the phase-locked loop is described. It first investigates the circuit's dynamics without and with random perturbations, but in the absence of external forcing. Next, the response of the circuit to noisy external signals is analyzed.

Interesting applications are also given in Chapter 11, in which the authors consider random perturbation of ecological systems, of epidemic disease processes, and of demographic models. Chapter 12 provides several concrete problems from genetics. In both chapters, the authors describe classical models for these phenomena and related results concerning their asymptotic behavior for large time.

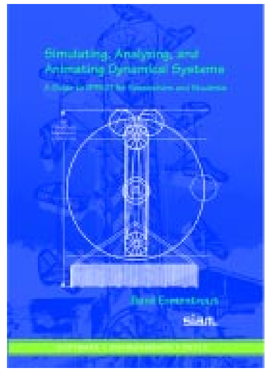
Appendix A recalls some basic notions of probability theory, and Appendix B contains historical comments and further remarks.

In summary, this reviewer would definitely recommend *Random Perturbation Methods with Applications in Science and Engineering* to those researchers and graduate students in Science and Engineering who require tools to investigate stochastic systems. The book qualifies to be a reference work that certainly would be a valuable addition in libraries of universities and laboratories pursuing research in Applied Mathematics.

7R4. Simulating, Analyzing, and Animating Dynamical Systems: A Guide to XPPAUT for Researchers and Students. - B Ermentrout *(Dept of Math, Univ of Pittsburgh).* SIAM, Philadelphia. 2002. 290 pp. Softcover. ISBN 0-89871-506-7. $63.00.

Reviewed by A Mahajan (Dept of Mech Eng and Energy Processes, S Illinois Univ, Carbondale IL 62901).

The book is a hands-on tutorial for a software package called XPPAUT. This software package is used for simulating, analyzing, and animating dynamic systems. Essentially, the software package provides numerical methods for the solution of a variety of equations, including ordinary differential equations, delay equations, integral equations, functional equations, and some partial differential equations, as well as boundary value problems. It introduces many modeling techniques and methods for analyzing the resulting equations. Other software packages that do the same are MATLAB, MAPLE, and MATHEMATICA. According to the author, the numerical integration in XPPAUT is faster than all of the other packages, but the most compelling reasons to use the software seem to be that it is free and provides an interface with AUTO, a continuation package. The intended audience for the book is researchers, system modelers in industry, instructors, and students.



This reviewer routinely uses MATLAB and has on occasion used MAPLE and MATHEMATICA, but had never come across XPPAUT. Hence, using a new software package, particularly because it was free (a copy can be downloaded from the author's website, which is given in the book), was exciting. But before one can run the software in the Windows environment, one has to install an X Windows Emulator. The book does a good job in pointing the readers to a few sites for demo versions that last for a few days or 30 minutes a session, after which one needs to buy one of these (the cost is quite nominal, from $25 to less than $250). This reviewer still had a few problems in getting the display to show up in the X window, but finally got it to work. A compiled version is also available for download that bypasses the need for X windows. Once XPPAUT is working on the desktop then it is fairly easy to follow the book. One of the strengths of the software package and the book is the easy and simple way to create input files that contain the differential equations. Printing can only be done through a PostScript printer or one has to go through a program called GhostView. This reviewer worked through quite a few examples and found the book well written and easy to follow. The animations were fairly easy to set up and were fairly well presented in the book. The book has a very good subject index, though the first chapter on installation could be better, especially for the Windows-based users who have never worked on UNIX systems or X Window Emulators. Further, for people used to working on Windows-based packages like MATLAB, navigating through the DOS-based XPPAUT could be fairly tedious.

Simulating, Analyzing, and Animating Dynamical Systems: A Guide to XPPAUT for Researchers and Students definitely lives up to the author's aim in providing a comprehensive tutorial for the XPPAUT software package in addition to the documentation that comes with the software. It would definitely help people who use the software package or would like to use it. The book is a softcover edition and is reasonably priced at $63. This reviewer would definitely recommend that libraries and serious individual users of the software package purchase the book.

7N5. Statistical Mechanics of Elasticity, 2nd Edition. - JH Weiner *(Brown Univ).* Dover Publ, Mineola NY. 2002. 439 pp. Softcover. ISBN 0-486-42260-7. $24.95.

This book is a slightly corrected republication of the original edition published by John Wiley and Sons, New York, in 1983.

Numerical Modeling in Materials Science and Engineering. Series in Computational Math, Vol 32. - M Rappaz *(Lab of Phys Metall, Swiss Fed Inst of Tech, Lausanne, 1015, Switzerland)*, M Bellet *(Ecole des Mines de Paris, CEMEF, Sophia Antipolis, 06904, France)*, M Deville *(Lab of Comput Eng, Swiss Fed Inst of Tech, Lausanne, 1015, Switzerland).* Springer-Verlag, Berlin. 2003. 540 pp. ISBN 3-540-42676-0. $89.95. (Under review)

Perturbation Methods for Differential Equations. - BK Shivamoggi *(Dept of Math, Univ of Central Florida, Orlando FL 32816-1364).* Birkhauser Boston, Cambridge MA. 2003. 354 pp. ISBN 0-8176-4189-0. $59.95. (Under review)

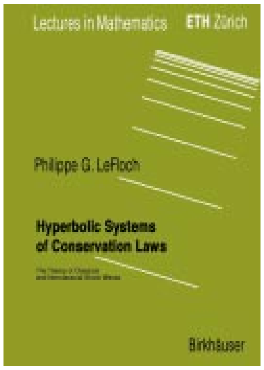
Tensor Analysis and Continuum Mechanics. - YR Talpaert *(Dept of Sci and Eng, Algiers Univ, Algeria).* Kluwer Acad Publ, Dordrecht, Netherlands. 2002. 591 pp. ISBN 1-4020-1055-9. $161.00. (Under review)

II. DYNAMICS & VIBRATION

7R6. Hyperbolic Systems of Conservation Laws: The Theory of Classical and Nonclassical Shock Waves. - PG LeFloch *(Center de Math Appliquees and CNRS, Ecole Polytechnique, Palaiseau, 91128, France).* Birkhauser Verlag AG, Basel, Switzerland. 2002. 294 pp. Softcover. ISBN 3-7643-6687-7. $34.95.

Reviewed by J Novotny (Inst of Thermomech, Dolejskova 5, Prague, 182 00, Czech Republic).

The book presents a self-contained modern mathematical theory of hyperbolic systems of nonlinear partial differential equations of first order in divergence form, which are also called hyperbolic systems of conservation laws. These equations arise in many areas of continuum physics (compressible fluid dynamics, phase transition dynamics, nonlinear elastodynamics . . .), where fundamental balance laws are formulated for mass, momentum, total energy of fluid, or solid continuum.



Solutions to these systems may lead to singularities (shock waves) appearing even when smooth initial data are given. As established, weak solutions are not unique unless some entropy condition is imposed.

The text contains existence, uniqueness, and continuous dependence of classical (compressive) entropy solutions on initial data. The latest results of the author and his collaborators on uniqueness of entropy solutions with bounded variations and continuous dependence are included.

Part one of the book describes scalar conservation laws and part two, systems of conservation laws. The Riemann problem, classical and nonclassical Riemann solvers are studied. Also the developing theory of nonclassical (under compressive) entropy solutions is presented. Existence theory for the Cauchy problem for classical entropy solutions, for both convex and general flux, and nonclassical entropy solutions are studied in detail. Continuous dependence of the solutions in L^1 norm is proved.

The study of nonclassical shock waves is based on the concept of a kinetic relation introduced by the author for general hyperbolic systems and derived from singular limits of hyperbolic conservation laws with balanced diffusion and dispersion terms.

Basic courses of functional analysis and modern methods for partial differential equations are necessary for studying of this book. No preliminary knowledge of continuum physics is required, however, basic knowledge is useful for better understanding.

The book contains a number of pertinent figures completing well the theoretical explanations. The book does not contain a subject index, nevertheless it contains bibliographical notes to each chapter and a large bibliography.

Up to now, no book clearly presented the most important principles of classical and modern theory of hyperbolic conservation laws together with recent developments in this field. This book, *Hyperbolic Systems of Conservation Laws: The Theory of Classical and Nonclassical Shock Waves*, can be considered as a concise and comprehensive monograph and at the same time a textbook for graduate students. The book should be particularly suitable for graduate students, courses for PhD students, and also for researchers working in the fields of modern theory and numerical analysis of nonlinear hyperbolic partial differential equations, and in theoretical continuum physics. It is suitable especially for young researchers, who want to become familiar with the basic principles, the current state of knowledge, and the latest, most important results in the mathematical theory of hyperbolic conservation laws.

This book is recommended for purchase by university libraries, departments of mathematics and physics, and seriously interested individuals.

7R7. Infinite-Dimensional Dynamical Systems: An Introduction to Dissipative Parabolic PDEs and the Theory of Global Attractors. Cambridge Texts in Applied Mathematics. - JC Robinson *(Math Inst, Univ of Warwick, UK).* Cambridge UP, Cambridge, UK. 2001. 461 pp. (Softcover). ISBN 0-521-63564-0. $110.00.

Reviewed by C Pierre (Dept of Mech Eng and Appl Mech, Univ of Michigan, 2250 GG Brown Bldg, Ann Arbor MI 48109-0001).

This volume in applied mathematics is concerned with the study of the longterm dynamics of partial differential equations (PDEs), with the aim of reducing dynamic behavior complexity. The approach is based on ideas from the theory of dynamical systems, which has proven successful for the study of finite-dimensional systems and for the past two decades or so has been developed for infinite-dimensional systems. The focus of this book is on dissipative parabolic PDEs, and particularly on the investigation of their asymptotic behavior by means of global attractors whose dynamics can be reproduced by a finite-dimensional system. As described in the Preface, the author aims to provide a systematic and rigorous treatment of the theory of global attractors. To do so he assumes minimum analytical background from the reader and begins with the basic foundation of functional analysis. As a result, the book provides both an in-depth, educated coverage of the tools necessary for the study of global attractors of PDEs and an authoritative account of the state-of-the-art in this evolving field.

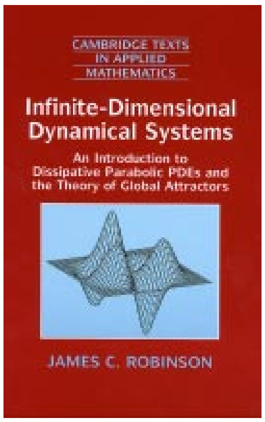
The volume is organized into four parts of four or five sequential chapters each, and two appendices. In the first part, the reader is given a rigorous exposition to the topic of functional analysis. Since this is required to understand the rest of the book, coverage is comprehensive and this part constitutes about one third of the volume. It includes chapters on Banach and Hilbert spaces, existence and uniqueness of solutions for ordinary differential equations, linear operators, and dual spaces, and concludes with a thorough treatment of Sobolev spaces. The second part of the book is concerned with the existence and uniqueness of solutions of time-dependent PDEs. Galerkin's method is first introduced on an example linear parabolic equation as a means of proving these properties. Then this approach is applied to investigate existence and uniqueness for scalar nonlinear reaction-diffusion equations and for two-dimensional Navier-Stokes equations with periodic boundary conditions. In the third part of the book, finite-dimensional global attractors are introduced: a general result to prove their existence is given, fractal and Hausdorff measures of their dimension are defined, and a method to estimate their dimension is proposed. These ideas are then applied to the examples of the reaction-diffusion and the Navier-Stokes equations. The fourth, and last, part investigates how the finite dimensionality of the global attractor can be exploited to reduce the complexity of the asymptotic dynamics of PDEs, namely, how the dynamics on the attractor are finite-dimensional. One chapter covers the squeezing property and its implications for finite-numbered "determining modes," approximate inertial manifolds, and exponential attractors. Another chapter introduces the "strong squeezing property" for the analysis of inertial manifolds. A third chapter gives a proof that the attractor dynamics can be reproduced by a finite-dimensional system, and a fourth, and final, chapter applies the various methods developed in the book to the analysis of the Kuramoto-Sivashinsky equation, which is used to model instabilities such as flame fronts. In addition, two useful appendices on Sobolev spaces of periodic functions and the bounding of fractal dimension support the material presented in the 17 chapters.

The book is written clearly and concisely. It is well structured, and the material is presented in a rigorous, coherent fashion. A number of example problems are treated, and each chapter is followed by a series of problems whose solutions are available on the internet. Although this is not an easy book to read, the informal style in which it is written and the pedagogical presentation of the material make it accessible to the reader. In summary, *Infinite-Dimensional Dynamical Systems: An Introduction to Dissipative Parabolic PDEs and the Theory of Global Attractors* constitutes an excellent resource for researchers and advanced graduate students in applied mathematics, dynamical systems, nonlinear dynamics, and computational mechanics. Its acquisition by libraries is strongly recommended.

7N8. Advances in Dynamic Equations on Time Scales. - Edited by M Bohner *(Dept of Math and Stat, Univ of Missouri-Rolla, Rolla MO 65409-0020)* and A Peterson *(Dept of Math and Stat, Univ of Lincoln-Nebraska, Lincoln NE 68588-0323).* Birkhauser Boston, Cambridge MA. 2003. 348 pp. ISBN 0-8176-4293-5. $69.95.

The current book is designed to supplement *Dynamic Equations on Time Scales: An Introduction with Applications* (M Bohner and A Peterson, Birkhäuser, 2001) and to offer access to the vast literature that has already emerged in this field. It consists of ten chapters, written by an international team of 21 experts in their areas, thus providing an overview of the recent advances in the theory on time scales.

Key topics include the exponential function on time scales, boundary value problems, positive solutions, upper and lower solutions of dynamic equations, alpha and nabla dynamic equations, integration theory on time scales, disconjugacy and higher order dynamic equations, and symplectic dynamic systems.



The book can be used as a textbook for a second course in dynamic equations. It also includes 114 exercises, a bibliography, and an index.

7N9. Progress in Computational Flow-Structure Interaction. Notes on Numerical Fluid Mechanics and Multidisciplinary Design, Vol 81. - Edited by W Haase *(EADS Military Aircraft, Dept MT63/Bldg 70 N, Munchen, D-81663, Germany)*, V Selmin *(Alenia Aeronautica, CP 432, Corso Marche, 41, Torino, I-10146, Italy)*, B Winzell *(Flutter and Loads Dept, Saab AB, Broderna Ugglas Gata, Linkoping, S-58188, Sweden).* Springer-Verlag, Berlin. 2003. 372 pp. ISBN 3-540-43902-1. $239.99.

This volume contains results gained from the EU-sponsored 4th Framework project, UNSI (Unsteady Viscous Flows in the Context of Fluid-Structure Interaction). Fifteen European organizations (industrial firms, research labs, and universities) have collaborated on the topic of nonlinear, static, and dynamic aeroelasticity applications with some special emphasis on the improvement of CFD methods applied to unsteady flow. The book is split into five main parts: project descriptions (with points of contact for the interested reader), summaries of work performed by each partner, summaries of work carried out in the job assignments, application-oriented syntheses, and conclusions and lessons learned.

Advances in Dynamics and Impact Mechanics. - Edited by CA Brebbia *(Wessex Inst of Tech, UK)* and GN Nurick *(Univ of Cape Town, S Africa).* WIT Press, Southampton, UK. Distributed in USA by Comput Mech, Billerica MA. 2003. 293 pp. ISBN 1-85312-928-3. $165.00. (Under review)

Computer Algebra Recipes for Classical Mechanics. - RH Enns *(Dept of Phys, Simon Fraser Univ, Burnaby, BC, V5A 1S6, Canada)* and GC McGuire *(Dept of Phys, Univ Col of Fraser Valley, Abbotsford, BC, V2S 7M9, Canada).* Birkhauser Boston, Cambridge MA. 2003. 264 pp. Softcover, CD-Rom included. ISBN 0-8176-4291-9. $54.95. (Under review)

III. AUTOMATIC CONTROL

7R10. Applied Linear Optimal Control: Examples and Algorithms. - AE Bryson *(Dept of Aeronaut and Astronaut, Stanford Univ, Stanford CA).* Cambridge UP, Cambridge, UK. 2002. 362 pp. Softcover, CD-Rom incl. ISBN 0-521-01231-7. $45.00. (Also available in Hardcover ISBN 0-521-81285-2, $120.00.)

Reviewed by M Reyhanoglu (Dept of Phys Sci, Embry-Riddle Aeronaut Univ, 600 S. Clyde Morris Blvd, Daytona Beach FL 32114).

This book updates and extends part of the material in *Applied Optimal Control* by Bryson and Ho [1]. In particular, it focuses on linear optimal control in the presence of uncertainties, including random inputs, measurement errors and model uncertainties. It completes the picture that has begun with the author's book *Dynamic Optimization* [2], a successor of the first part of [1], which deals with the deterministic (nonrandom) case.

The book commences in Chapter 1 with an overview of random variables and static estimation. In Chapter 2, discrete and continuous linear Gauss-Markov processes are introduced. Chapter 3 treats discrete and continuous filtering. Both time-invariant and time-varying Kalman and Kalman-Bucy filters are discussed and new software codes are presented. Chapter 4 covers smoothing without control inputs and discusses both batch and recursive algorithms. Chapter 5 is devoted to the synthesis of time-varying linear quadratic followers and terminal controllers for deterministic systems using state feedback. Chapter 6 treats linear-quadratic-Gaussian (LQG) controllers, which use output measurements instead of full state feedback. Chapter 7 extends the ideas in Chapter 4 to include smoothing of data from runs of controlled plants. Both batch and recursive algorithms are presented and demonstrated on examples. Chapter 8 presents discrete and continuous time-invariant filters. Chapters 9 and 10 treat time-invariant linear-quadratic (LQ) state feedback controllers and LQG controllers, respectively. Chapter 11 presents discrete and continuous linear-quadratic worst-case (LQW) controllers and estimators. Chapter 12 develops a parameter-robust LQG controller design method based on minimizing the maximum quadratic performance index at the corners of a specified plant parameter space. The resulting controllers are shown to achieve best performance for a specified plant-parameter robustness. The book concludes with two appendices: one appendix covers filters and controllers with colored measurement noise, and the other appendix contains mathematical models of plants used in the examples and problems.

The book is written as a theoretical and practical tool for anyone involved in optimal control. The author has carefully collected many realistic examples drawn from diverse engineering fields. The examples are very helpful in explaining new concepts and ideas behind theories. Intriguing problems are available within each chapter. In an effort to close the gap between theory and practice, computational algorithms are included for solving practical optimization problems. The algorithms are coded in MATLAB. Students are asked to write simple MATLAB programs as they progress through the book, to convince themselves that they have confidence in the theory and understand its practical implications.

The author stated the goal at the beginning of the book as ''to aid readers in utilizing the theory of optimal control to solve practical problems in the face of uncertainty.'' It appears this goal has been achieved. *Applied Linear Optimal Control: Examples and Algorithms* should be a good addition to the optimal control community. It makes an excellent text for engineering and applied mathematics students who already have some optimal control background. It is strongly recommended as a helpful guide for anyone who desires to learn and apply many of the current state of the art results in optimal control.

References

[1] Bryson AE and Ho YC, 1975, *Applied Optimal Control*, Hemisphere, New York.
[2] Bryson AE, 1999, *Dynamic Optimization*, Addison Wesley Longman, Menlo Park CA.

7N11. Control and Modeling of Complex Systems: Cybernetics in the 21st Century. Festschrift in Honor of Hidenori Kimura on the Occasion of his 60th Birthday. - Edited byK Hashimoto *(Dept of Info Phys and Computing, Univ of Tokyo, Hongo 7-3-1, Bunkyo-ku, Tokyo, 113-8656, Japan)*, Y Oishi *(Dept of Math Informatics, Univ of Tokyo, Hongo 7-3-1, Bunkyo-ku, Tokyo, 113-8656, Japan)*, Y Yamamoto *(Dept of Appl Anal and Complex Dyn Sys, Kyoto Univ, Yoshida-Honmachi, Sakyo-ku, Kyoto, 606-8501, Japan).* Birkhauser Boston, Cambridge MA. 2003. 337 pp. ISBN 0-8176-4325-7. $74.95.

This volume pays tribute to Hidenori Kimura and his outstanding achievements in control theory, signal processing, and modeling. It contains 20 invited contributions. The chapters are classified into five main areas related to Kimura's work: signal processing; identification; robust control; hybrid, chaotic, and nonlinear systems; and control applications.

7N12. Nonlinear and Hybrid Systems in Automotive Control. - Edited by R Johansson and A Rantzer *(Dept of Autom Control, Lund Univ, PO Box 118, SE-221 00, Lund, Sweden).* Springer-Verlag London Ltd, Surrey, UK. 2003. 440 pp. ISBN 1-85233-652-8. $119.00.

This book on automotive control presents an overview of the research area and collects contributions from a number of leading scientists in the field. It contains contributions on vehicle dynamics and active suspension; anti-lock braking systems, brake dynamics, friction and wheel-slip modeling; combustionengine control; and system theory and hybrid system analysis for application in automotive control.

IV. MECHANICS OF SOLIDS

7R13. Functional Analysis in Mechanics. - LP Lebedev *(Dept of Math, Univ Nacional de Colombia, Bogota, Colombia)* and II Vorovich *(Deceased).* Springer-Verlag, New York. 2003. 238 pp. ISBN 0-387-95519-4. $59.95.

Reviewed by I Andrianov (Inst fur Allgemeine Mechanik, RWTH, Templergraben 64, Aachen, D-52056, Germany).

This textbook is based on the course of lectures on functional analysis delivered to students of the Department of Mathematics and Mechanics (division of Mechanics) at Rostov State University (USSR, Russia). Outstanding scientist and tutor Professor II Vorovich initiated this course about 30 years ago. Many known scientists in the field of Mechanics were graduated from Rostov State University, so we can consider that the course itself has gotten a good approval. It is very good news that from now on, it may be used by Western students and scientists.

The book is divided into three parts: metric spaces, theory of operators, and nonlinear functional analysis. A brief description of the book's layout is given below.

Part 1 is devoted to energy; Banach, Hilbert, and Sobolev spaces; convergence, weak convergence, completeness, compactness, and separability; weak and generalized solutions in Mechanics; Hausdorf criterion; Arzelà's and decomposition theorems; Riesh representations; Ritz and Bubnov-Galerkin methods; and the Bramble-Hilbert lemma. A variant of elastico-plasticity proposed by Il'yushin is considered, and the method of elastic solutions for corresponding boundary value problems is justified.

Part 2 treats the Banach-Shteinhause principle; inverse, closed, and compact operators; spectrum and resolvent of linear operators; some applications of spectral theory; and the Courant minimax principle.

In Part 3, Fréchet and Gateaux derivatives, Liapunov-Shmidt method, critical points of a functional, von Kármán equations of a plate, buckling of a thin elastic shell and equilibrium of elastic shallow shell, degree theory and steady-state flow of viscous liquid are discussed.

The purpose of the book is to offer quick access to the principal facts so the reader could rapidly gain familiarity with this valuable tool. General ideas and algorithms are clear and understandable. There is a good index attached.

In this reviewer's opinion, the book has two shortcomings. First, there are no exercises to enable readers to check their understanding of the techniques employed and, in some cases, to amplify what has been described in the text. Second, the book does not contain a list of symbols. Such a list facilitates reading in cases where the symbol is not defined on the page being read.

As the authors put it, a knowledge of mechanics is not necessary. Generally, it is true, but my advice to newcomers familiar with mechanics, but not so good in mathematics, is to start with *Functional Analysis in Mechanics*—just for deeper mathematical understanding of problems considered.

The authors also tried to make the course self-contained and to cover the foundations of functional analysis. They have succeeded indeed, but for readers unexperienced in Functional Analysis, it would be better to also use a good mathematical course, for example, *Introductory Real Analysis*, by AN Kolmogorov and SV Fomin (Dover, New York, 1975).

This skillfully-written book is a reader-friendly and well-organized textbook in the field of Mathematical Mechanics. It can be highly recommended for students of technology universities as well as for researchers in Mechanics. In addition, this reviewer would like to recommend *Functional Analysis in Mechanics* for technology university lecturers as the basis for a lecture course. The book is recommended for purchase by university libraries and for individuals interested in the mathematical problems of Mechanics.

7R14. Models and Phenomena in Fracture Mechanics. Foundations of Engineering Mechanics. - LI Slepyan *(Dept of Solid Mech, Mat, and Syst, Tel Aviv Univ, Ramat Aviv, 69978, Israel).* Springer-Verlag, Berlin. 2002. 576 pp. ISBN 3-540-43767-3. $229.00.

Reviewed by AS Grandt (Sch of Aeronaut and Astronaut, Purdue Univ, 1282 Grisson Hall, W Lafayette IN 47907-1282).

The author's objective for this 14-chapter volume is to provide a broad overview of various models of cracks, material behavior, and crack growth that characterize the general fracture process. He discusses, for example, how crack tip stresses may be modeled by singular stress fields or by finite stresses in cohesive zone models. Material behavior is represented by linear and nonlinear elastic, viscoelastic, elastic-plastic, and porous material descriptions, as well as by elastic and viscoelastic lattice models. The ultimate goal of all these approaches is to determine how a crack grows under certain conditions or whether it remains stable.

Chapter 1 reviews fundamental fracture mechanics concepts and presents several methods for determining the energy released by crack growth. The author characterizes Chapters 2 and 3 as "auxiliary material" that leads to a better understanding of fracture mechanics phenomena (eg, Fourier transforms and various aspects of wave propagation). Chapter 4 describes a one-dimensional view of crack growth, while Chapter 5 gives two- and three-dimensional treatment of static cracks in linear elastic bodies. Nonlinear elastic bodies are then discussed in Chapter 6, followed by viscoelastic fracture in Chapter 7, elastic-plastic fracture in Chapter 8, and dynamic fracture in Chapter 9.

Chapter 10 deals with crack growth in plate bending where one must take into account the possibility for crack surfaces to come into contact. Chapters 11–14 conclude the text with discrete models for dynamic and quasi-static fracture and phase transition. First, square-cell elastic and viscoelastic lattices are discussed in Chapter 11, followed by triangular cell elastic lattices in Chapter 12. Two-phase models of phase transition are then presented in Chapter 13, concluding with dynamic aspects of fracture and phase transformation in Chapter 14.

The author has researched fracture mechanics problems since the late 1960s and has obtained vast experience with the key technical issues. He has had the opportunity to meet and interact with many other important investigators involved in related research topics. Indeed, one of the book's key attributes is the wide-ranging background and mathematical rigor that the author brings to the fracture mechanics arena. The book's 576 pages present a total of 142 figures, 274 references, and over 2300 equations. *Models and Phenomena in Fracture Mechanics* will be of main interest to researchers, with a strong fracture mechanics background, who desire a rigorous description of many different approaches to modeling the fracture process. The text also will serve as a guide to the vast literature on these topics.

7N15. Dynamics of Heterogeneous Materials. - VF Nesterenko *(Dept of Mech and Aerospace Eng, UCSD, La Jolla CA 92093-0411).* Springer-Verlag, New York. 2001. 510 pp. ISBN 0-387-95266-7. $139.00.

This monograph describes the mechanical, physical, and chemical phenomena in powders and other heterogeneous materials under high-pressure dynamic deformation. The discussion does not take the traditional approach based on the Hugoniot equations, but views the topic from the point of view of nonlinear phenomena and materials science, emphasizing those aspects of the behavior that are sensitive to structural details.

Based on experimental observations, the treatment focuses on strongly nonlinear phenomena, such as shock waves, solitons, and localized shear. It takes into account effects of materials structure whose size is on the same order as the scale of parameter variation (such as the shock front or shear band thickness). Experimental results are presented in a manner that allows others to repeat the experiments or for validation in analytical or numerical modeling. The author introduces models that can be verified by experiments.

Intended for graduate students as well as researchers, the book includes more than 90 problems at the ends of chapters to help the reader develop a deeper understanding of the material.

7N16. IUTAM Symposium on Mechanics of Martensitic Phase Transformation in Solids. Proc of IUTAM Symp, Hong Kong, June 2001. - Edited by QP Sun *(Hong Kong, China).* Kluwer Acad Publ, Dordrecht, Netherlands. 2002. 250 pp. ISBN 1-4020-0741-8. $96.00.

This volume presents 29 written contributions from invited speakers to the 1st IUTAM Symposium on this topic. The invited lectures cover seven different topics: Microstructure and deformation of interfaces and moving boundaries; Material instability and its propagation during martensite phase transformation; Micromechanics description of constitutive behavior of representative volume element; Interactions between plasticity (dislocation) and phase transformation; Martensitic phase transformation in thin films; Size effect and scaling in martensitic phase transformations; and Engineering applications of phase transformations in bio-materials and medical devices, intelligent materials and structures, TRIP steels, MEMS, shape memory alloys, and shape memory polymers.

7N17. Mechanical Properties of Engineered Materials. - W Soboyejo *(Princeton Univ, Princeton NJ).* Marcel Dekker, New York. 2002. 608 pp. ISBN 0-8247-8900-8. $185.00.

This book presents a concise overview of the mechanical properties of engineering materials and structures and highlights the latest in basic materials concepts, including the mechanics and physical basis of elasticity, plasticity, fracture, fatigue, viscoelasticity, creep, and time dependent fracture. It is organized into 15 chapters and has 171 references.

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. (Under review)

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. (Under review)

V. MECHANICS OF FLUIDS

7R18. Multiphase Flow Dynamics, Volume 1: Fundamentals; Volume 2: Thermal and Mechanical Interactions. - NI Kolev *(Framatome ANP GmbH, PO Box 3220, Erlangen, 91050, Germany).* Springer-Verlag, Berlin. 2002. 699 pp. CD-Rom included. ISBN 3-540-42984-0. $139.00. Volume 2 ISBN 3-540-43017-2, 692 pp, $139.00.

Reviewed by RW Lyczkowski (Energy Syst Div, Argonne Natl Lab, Bldg 362, Rm C348D, 9700 S Cass Ave, Argonne IL 60439-4815).

This is a dual review, so it will be longer than normal. There are 13 Chapters in Volume 1 (98 figures) and 26 Chapters in Volume 2 (77 figures) as listed below. Chapter 13 of Volume 1 and Chapter 26 of Volume 2 are available on an attached CD-ROM in pdf format. The system requirements are Windows 98 and higher. Both pdf files contain links to the computer animations. To see the animations, one double clicks on the active links contained inside the pdf documents. The animations are then displayed in an internet browser, such as Microsoft Internet Explorer or Netscape. Alternatively, gif-file animations are also provided. The books are described as a monograph in the Table of Contents. They are not textbooks, as there are no problems. There are a few examples scattered throughout the text, but most of them are contained on the CD-ROM attached to Volume 1.

The author is identified as being with Framatome ANP Gmbh in Erlangen, Germany, a large multinational company second in size to GE. The monograph is the result of 20 years of research and experience and is claimed to be a handbook of three-dimensional multiphase numerical modeling (at least in the context of nuclear safety analysis). The author is to be commended for gathering and updating his research and reviewing that of a great many others together in one place and attempting to make a cohesive whole.

Reading the Introduction and Summary, one gets the impression that a very general multiphase local volume-averaging approach is going to be adopted in Volume 1, Fundamentals, using what is referred to as the *Slattery-Whittaker* theorem together with the *Leibnitz* rule. In fact, the theoretical framework adopted is that of Sha, Soo, and Chao (*Nuclear Eng Design*, Vol 82, pp 93–106, 1984), and *not* that of Slattery (*Advanced Transport Phenomena*, Cambridge Univ Press, 1999), Soo (*Multiphase Fluid Dynamics*, Science Press, distributed by Gower Technical, 1990, a revision of Soo's landmark *Fluid Dynamics of Multiphase Systems*, 1967), or Gidaspow (*Multiphase Flow and Fluidization Continuum and Kinetic Theory Descriptions*, Academic Press, 1994), for example, (none of which are referred to) or the references cited. The Sha, Soo, and Chao approach is in fact an artifice, which justified the numerical construct of surface permeabilities, sometimes called area factors, in thermal hydraulics and nuclear safety computer programs resulting from the control volume approach. A single parameter, the porosity, results from rigorous local volume averaging. The approach is immediately reduced to the case of only three fluids, ie fields or phases. A novel feature is the treatment of multi-component three-field flow. Fluid-solids systems, per se, ie, fluidized beds, pneumatic conveying, etc, are not to be found here and this literature is not referred to except indirectly in the context of correlations for particle fragmentation and coalescence. This is understandable as the author's background is in nuclear safety analysis.

The author rightly points out that none of the above references, nor his, treat the numerical aspects of multiphase flow, and this is correct. Gidaspow's book presents the results of many numerical simulations and comparisons with experiment, but fails to describe the numerical methods. Such numerical methods are scattered throughout the literature. Again the author maintains that there remains a lack of a systematic presentation of theory and numerical multiphase fluid dynamics. To address this deficiency, the author states that the emphasis of the book is the generic links of the computational predictions with 1) fundamentals, 2) numerical methods, 3) empirical or constitutive interfacial phenomena, and 4) comparisons with experimental data. The author's collected research on the three-fluid entropy and exergy concept, the rigorous thermodynamic treatment of multicomponent systems, and an exposition of boundary fitted description and numerical treatment in Cartesian, cylindrical and curvilinear coordinates for three fields are claimed to be presented in this monograph for the first time.

The monograph is intended for applied scientists, practicing engineers, graduate students, and doctoral research programs. Does in fact the monograph achieve its claimed objectives? So-called modeling hints and details are given on the CD-ROM using many comparisons of predictions with experimental data. With these hints, the author claims that the reader can write his own computer programs. The incredible detail and confusing nomenclature in Volume 1 offered this reviewer a serious impediment to understanding and progress through the fundamentals development. A lot more of the details could have been relegated to Appendices, either at the end of the chapters or at the end. If an expert has problems following the development of fundamentals, then what chance does the novice applied scientist, practicing engineer, or graduate student have in digesting the great magnitude effort?

Volume 1 has a global Nomenclature section, but Volume 2 has a separate Nomenclature section in each and every chapter. Therefore, there is little likelihood that the Nomenclature for the fundamentals and numerical method in Volume 1 is consistent with the correlations and models contained in Volume 2. This reviewer admits to have not checked for consistency. Key superscript and subscript notations in Volume 1 are missing in the Notation section. These include, but are not limited to the following:

Superscripts

e defined by Eq. 1.11 as "heterogeneous"

l defined by Eq. 1.15 as "intrinsic" field average

le defined by Eq. 1.17 as intrinsic surface average (for field l)

$l\sigma$ defined implicitly on page 13 in $\mathbf{V}_{l\sigma}^{\tau}$ instantaneous interfacial

τ implicitly defined by $\mathbf{V}_{l}^{\tau}$ means "instantaneous" in Nomenclature

Subscripts

DT^{N} defined on page 204.

The grammar is a little awkward in places, and there are typographical errors scattered throughout both Volumes 1 and 2. A little more editorial assistance could have been used. Some examples are: Hetsroni is consistently misspelled as Hetsrony; the subheading 1.4 on page 10 is corrupted; Eq. (1) and Eq. (28) in Fig. 2.4 should be Eq. (2.1) and Eq. (2.28). In a book of this complexity, such things are to be expected in the first printing.

There are very few explanations as to how the correlations in Volume 2 are to be meshed with Volume 1. There is no clear discussion of how the energy is to be partitioned for the various heat transfer mechanisms eg, bubble growth in a superheated liquid, condensation in a subcooled liquid, etc. One of the first attempts to derive a consistent methodology to do so was published by Solbrig, Hocevar, and Hughes (Preprints of AIChE Papers 17th National Heat Transfer Conference, Salt Lake City Aug, 14–17, 1977, AIChE, New York, 1977). The IVA series of codes developed by the author and colleagues embody this linkage. Why not make a generic version of this code available with the monograph, or maybe a few templates?

Each chapter has its own Reference section. There is a general Index section at the end of each volume. SI units are used exclusively. The figures (some of which are in color), tables, and equations are of extremely high quality. The book is sturdily bound with an attractive matte cover and is printed on acid free paper. The monograph will be of use as a general reference to specialists in the area of thermal hydraulics and nuclear reactor safety. The preponderance of references by the author (most chapters are mostly references to the author's works) in technical reports and conference proceedings will make it difficult to obtain the original sources of the revisions contained in the monograph. Can the monograph be used to write computer programs using the fundamentals and correlations? This reviewer seriously doubts that anyone could write their own code based on this monograph. The correlations from Volume 2 might be programmed into existing computer programs.

The chapters in the two volumes are organized as follows with brief descriptions or highlights. Subtitles are not listed as the length would be excessive.

The chapters of Volume 1, *Fundamentals*, include the following:

Mass conservation (44 pp)—Fig. 1.1 is pretty, but meaningless and confusing, also appears as Fig. 1.1 in Volume 2.

Momentum conservation (70 pp)

Derivatives for the equations of state (52 pp)—Thermodynamic derivatives are derived for several planes for multicomponent mixtures. The two appendices present derivatives for steam/air and solid and liquid uranium dioxide. The entire chapter could have been relegated to an Appendix.

Variety of notations of the energy conservation for single-phase flow (36 pp)—This chapter serves as an introduction to Chapter 5. The energy equation is expressed in terms of internal energy, temperature, entropy, and enthalpy without conduction. The one-dimensional equations are transformed into canonical form using the method of characteristics (MOC) and solved for a shock tube simulation and an error analysis is performed. An appendix analyzes the accuracy of the donor-cell differencing compared with the MOC.

First and second laws of the thermodynamics for multi-phase multi-component flows (70 pp)—This chapter continues Chapters 1 and 2. The "general" energy equation for three fluids in a porous medium is expressed in terms of internal energy, temperature, entropy and enthalpy.

Some simple applications of the mass and energy conservation for multi-component single-phase systems (18 pp)—Several analytical solutions are obtained which can serve as benchmarks for computer codes.

Exergy of multi-phase multi-component systems (16 pp)—Exergy is defined in accordance with several investigators and applied to a three-fluid multi-component system.

One-dimensional three-fluid flow (86 pp)—The mass, momentum, and entropy equations summarized in Chapters 1, 2, and 5 are simplified and cast into canonical form using the MOC. Transient and steady-state flow equations are derived using the slip ratio model.

Detonation waves in melt-coolant interaction (34 pp)—Shock wave relations are derived for water in contact with molten iron or uranium dioxide and a numerical solution is presented.

Conservation equations in general curvilinear coordinate systems (34 pp)

Numerical solution methods for multi-phase flow problems (92 pp)—Discretizations of the equations presented in Chapters 1, 2, and 5 are given using donor cell differencing for low-order terms and central differencing for second-order terms as programmed in the IVA series of computer codes (IVA2 through IVA6). The Newton-Raphson iteration scheme and higher order discretizations schemes are discussed. A section on pipe flow network definitions is included. Eight appendices give details of the discretizations definitions and one simple iterative method. The IMF (Harlow and Amsden, *J Comp. Phys*, Vol 17, 1975) and K-FIX (Rivard and Torrey, LA-NREG-6623, 1977) numerical solution schemes developed at Los Alamos National Laboratory, for example, are not discussed.

Numerical solution method for multi-phase flow problems in curvilinear coordinate systems (54 pp)—This chapter is parallel in construction to Chapter 11. The reader is urged to read Appendices 1 and 2 before reading this chapter. Four appendices give details of the discretization definitions.

Appendix 1 offers a *Brief introduction to vector analysis* (28 pp) and Appendix 2 covers *Basics of the coordinate transformation theory* (56 pp). Also included is *Visual demonstration of the method* (40 pp on CD-ROM), as well as a seven-page Index.

The chapters of Volume 2, *Mechanical and Thermal Interactions*, include the following:

Flow regime transition criteria (26 pp); *Drag forces* (42 pp); *Friction pressure drop* (16 pp) [Govier and Aziz, "The Flow of Complex Mixtures in Pipes, Van Nostrand Reinhold Co., New York, 1972 contains much more information covering Chapters 1 through 3; however it is not up to date and is long out of print]. *Diffusion velocities for algebraic slip models* (46 pp); *Entrainment in annular two-phase flow* (18 pp); *Deposition in annular two-phase flow* (14 pp); *Introduction to fragmentation and coalescence* (22 pp); *Acceleration induced droplet and bubble fragmentation* (48 pp); *Turbulence induced particle fragmentation and coalescence* (26 pp); *Liquid and gas jet disintegration* (26 pp); *Nucleation in liquids* (32 pp); *Bubble growth in superheated liquid* (24 pp); and *Condensation of a pure steam bubble in a subcooled liquid* (22 pp). Chapters 7 through 10 are a review of the subjects of fragmentation and coalescence. *Fragmentation of melt in coolant* (52 pp)—The major portion addresses thermo-mechanical fragmentation of liquid metals in water with additional sections on particle production, thermal fragmentation and oxidation. Chapters 12 through 14 are reviews of the subjects of nucleation, bubble growth, and condensation.

Continuing on with the chapters: *Bubble departure diameter* (18 pp)—A new model is developed and compared with experimental data.

How accurately can we predict nucleate boiling? (28 pp)—This chapter is a revised version of a new theory previously published by the author. An Appendix reviews the state of the art of modeling nucleate pool boiling.

Heterogeneous nucleation and flashing in adiabatic pipes (22 pp)—A new model is developed for heat and mass transfer for bubble fragmentation and coalescence and compared with data.

Boiling of subcooled liquid (10 pp)—Heat and mass transfer correlations are presented.

Natural convection film boiling (6 pp)

Forced convection boiling (22 pp)—A collection of heat and mass transfer correlations is presented for convection boiling, transition boiling, and critical heat flux.

Film boiling on vertical plates and spheres (42 pp)—A closed form analytical solution is presented for mixed-convection film boiling on vertical walls and on a sphere and compared with experimental data. There are two short appendices on natural and force convection.

Liquid droplets (36 pp)—The chapter presents correlations for nucleation of condensing subcooled steam, interfacial heat transfer without mass transfer, direct contact condensation of steam on a subcooled droplet, flashing of superheated droplets, evaporation of saturated droplets into superheated gas and gas mixture containing an inert.

Heat and mass transfer at the film-gas interface (26 pp)—The chapter presents correlations for convective heat transfer, flashing of superheated films, evaporation of saturated films in a superheated gas, condensation of pure steam on subcooled films and the effect of noncondensibles.

Condensation at cooled walls (14 pp)

Implementation of the discrete ordinate method for radiation transport in multiphase computer codes (46 pp)—A summary of the method is presented and the development of the radiation transport model for the IVA computer code initially developed without obstacles is extended to handle internal obstacles.

Validation of multi-phase flow models by comparison with experimental data and analytical benchmarks (92 pp on CD-ROM attached to Vol 1)

The first volume, *Multiphase Flow Dynamics 1: Fundamentals*, should be purchased by libraries for reference and by researchers in the field of thermal hydraulics in the nuclear safety industry. *Volume 2, Thermal and Mechanical Interactions* could be of use in other fields of research for the wealth of correlations contained therein.

7N19. Numerical Flow Simulation III: CNRS-DFG Collaborative Research Program, Results 2000–2002. Notes on Numerical Fluid Mechanics and Multidisciplinary Design, Vol 82. - Edited by EH Hirschel *(Herzog-Heinrich-Weg 6, Zorneding, D-85604, Germany).* Springer-Verlag, Berlin. 2003. 285 pp. ISBN 3-540-44130-1. $199.00.

This volume contains 18 reports on work that has been conducted since 2000 in the Collaborative Research Program ''Numerical Flow Simulation'' of the Center National de la Recherche Scientifique (CNRS) and the Deutsche Forschungsgemeinschaft (DFG). French and German engineers and mathematicians present their joint research on the topics: Development of solution techniques, Crystal growth and melts, Flows of reacting gases, Sound generation, and Turbulent flows.

Design Sensitivity Analysis: Computational Issues of Sensitivity Equation Methods. - LG Stanley *(Montana State Univ, Bozeman MT)* and DL Stewart *(Air Force Inst of Tech, Wright Patterson Air Force Base, WPAFB OH).* SIAM, Philadelphia. 2002. 139 pp. ISBN 0-89871-524-5. $65.00. (Under review)

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. (Under review)

Foundations and Applications of Mechanics, Volume II: Fluid Mechanics. - CS Jog *(Dept of Mech Eng, Indian Inst of Sci, Bangalore, 560 012, India).* Narosa Publ, New Delhi, India. Distributed in USA by CRC Press LLC, Boca Raton FL. 2002. 435 pp. ISBN 0-8493-2413-0. $89.95. (Under review)

Perspectives in Flow Control and Optimization. - MD Gunzburger *(Iowa State Univ, Ames IA).* SIAM, Philadelphia. 2003. 261 pp. ISBN 0-89871-527-X. $70.00. (Under review)

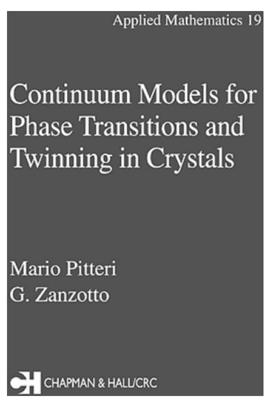
Plasma and Fluid Turbulence: Theory and Modelling. Series in Plasma Physics. - A Yoshizawa *(Inst of Indust Sci, Univ of Tokyo, Japan),* S-I Itoh *(Res Inst for Appl Mech, Kyushu Univ, Japan),* K Itoh *(Natl Inst for Fusion Sci, Toki, Japan).* Inst Phys Publ, Bristol, UK. 2003. 459 pp. ISBN 0-7503-0871-0. $135.00. (Under review)

VI. HEAT TRANSFER

7R20. Continuum Models for Phase Transitions and Twinning in Crystals. Applied Mathematics, Volume 19. - M Pitteri and G Zanzotto *(Dept of Math Methods and Models for Appl Sci, Univ of Padova, Italy).* Chapman and Hall/CRC, Boca Raton FL. 2003. 385 pp. ISBN 0-8493-0327-3. $99.95.

Reviewed by CA Rossit (Dept de Ingenieria, Univ Nacional del Sur, Avenida Alem 1253, Bahia Blanca, 8000, Argentina).

This nicely written textbook for graduate students and researchers is an extremely valuable reference treatise for anyone undertaking research in these areas, basically the nonlinear thermoelastic theories for twinning and phase transitions in crystalline materials. The field goes from very deep theoretical issues in mathematical physics to very important problems in material science.



As pointed out by the authors, several definitions and remarks on the phenomenon of twinning are given by many distinguished researchers. However, they have selected the standard viewpoint stating that ''a twin is a polycrystalline edifice built up of two or more homogeneous portions of the same crystal species in juxtaposition and oriented with respect to one another according to well defined laws.'' Twins are generally classified according to their physical origin. Hence growth, deformation, and transformation twins are often distinguished.

The authors present fundamental experimental facts regarding twins originated during growth or along phase transformations or by mechanical deformation, along with early geometric theories, in Chapter 1.

Chapter 2 reviews basic concepts for the treatment of the subject. The molecular model of a simple (mono—atomic) lattice is introduced in Chapter 3 in order to describe periodicity of crystalline solids.

Chapter 4 deals with weak-transformation neighborhoods and variants, while Chapter 5 is concerned with explicit variant structures.

In Chapter 6, titled *Energetics*, a nonconvex energy function per unit cell of the lattice is introduced, following concepts developed by Cauchy. This molecular apparatus is connected to elasticity theory using a hypothesis due to Cauchy and improved by Born (''Born rule'').

Chapter 7 depicts some results regarding bifurcation patterns that are possible during solid-state phase transitions involving changes of symmetry in simple lattices. This approach was first introduced by Landau.

The concept of mechanical twinning deformations is introduced in Chapter 8, which ends up with a synthetic discussion, leading to treating the Born rule with caution. This leads to interesting applications in the Earth Sciences as shown by Zanzotto in an earlier contribution.

Transformation twinning is studied in Chapter 9 while Chapter 10 deals with the modeling of various complicated microstructures often found in crystals of shape memory alloys.

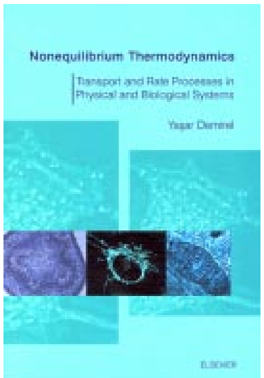
Multilattice is introduced in Chapter 11, and the relevant variables are defined and studied with particular application to the twinning mode in hexagonal metals and the twinning mode of β-tin.

The authors greatly succeed in achieving their stated aims and stimulate deep interest in the subject matter. This reviewer welcomes the appearance of *Continuum Models for Phase Transitions and Twinning in Crystals* in the world scientific literature.

7R21. Nonequilibrium Thermodynamics: Transport and Rate Processes in Physical and Biological Systems. - Y Demirel *(Dept of Chem Eng, VPI, 127 Randolph Hall, Blacksburg VA 24061).* Elsevier Sci BV, Amsterdam, Netherlands. 2002. 420 pp. ISBN 0-444-50886-4. $210.00.

Reviewed by S Sieniutycz (Dept of Chem and Process Eng, Warsaw Univ of Tech, 1 Warynskiego St, Warsaw, 00-645, Poland).

The book is, in fact, a volume for readers primarily interested in life sciences (physiology, biology, medicine, etc) or related fields, where insight is more important than exactness, at least initially. Formally, a broader audience has been assumed for the book by the publisher: graduate students and researchers working in the areas of physics, chemistry, biology, chemical engineering, biochemical engineering and biomedical engineering. Yet, especially in teaching students of physics and theoretical chemistry, the use of more rigorous treatments such as the classical textbook by De Groot and Mazur will be necessary. In addition, the book contains introductory information on several new growing applied branches of non-equilibrium thermodynamics (for example: applications of entropy and the second law in chemical engineering, exergy balancing, thermoeconomics, coupling systems theory, bioenergetics in mitochondria, active transport, etc).



The book attempts to give the reader a broad, updated review of applications of the theory of nonequilibrium processes. To warrant the self-contained structure of the volume, two preparatory chapters are included of which the first is on equilibrium thermodynamics and the second on transport and rate processes. The basic intention of the author seems to be to bring together many important developments in irreversible thermodynamics of recent years at an elementary level, and thereby render them accessible to a broad audience of beginners. The book extends the range of applied topics covered in earlier treatments of the subject by including some contemporary applications which are still at the research stage.

The goals and contents of the book along with basic historical aspects of the discipline are defined in the Preface (a Foreword, actually). The content is organized reasonably, thus a beginner finds a relatively simple and transparent picture of the field. Chapter 1 is on equilibrium thermodynamics. It describes basic definitions, reversible and irreversible processes, equilibrium, thermodynamic laws, entropy and entropy production, the Gibbs equation, equations of state, and thermodynamic potentials. The brief review of classical issues is done well. Yet the sections on thermodynamic potentials and extremum properties are somewhat inconclusive. Chapter 2 is on transport and rate processes. It introduces nonequilibrium systems and outlines such issues as: kinetic approach, transport phenomena, the Maxwell-Stefan equations, transport coefficients, electric charge flow, the thermal relaxation theory, preliminaries on chemical reactions and coupled processes.

Chapter 3 deals with linear nonequilibrium thermodynamics. Its sections discuss local thermodynamic equilibrium, second law of thermodynamics, phenomenological equations, Curie-Prigogine principle, dissipation function, and variation of entropy production. Chemical affinity A appears in Section 3 (satisfying the convention that the affinity is positive when the reaction rate is positive), and the limiting linear formulas in this section are consistent with this convention. This chapter serves to prepare the reader to understand why the proportionality between A and the reaction rate J can be assumed in linear descriptions. In discussing this particular chapter, it seems especially appropriate to recall that the elementary nature of the book does not release its author from the satisfaction of a certain degree of rigor and completeness. Unfortunately, the degree of oversimplification and incompleteness in this material is so large that the text often resembles careless lecture notes. In the text devoted to the local equilibrium assumption no discussion on the effect of time (spatial) scales is included, and the role of Knudsen's number is not considered. The nonequilibrium nature of Gibbs equation is not discussed. The notion of dissipation function in the force representation is identified in Section 5 (modulo to the temperature factor) with that of the entropy production. In general, no sharp distinction is made between the bilinear structures describing entropy production and quadratic functions of dissipation.

Chapter 4 is on balance equations and entropy generation in continua where field description is applied and partial differential equations are suitable in the thermodynamic description. Basic equations are obtained by the standard procedure that combines the conservation laws for mass, energy and momentum into the internal energy equation. Next, with the help of the Gibbs equation, the internal energy equation is transformed into an equation describing the entropy balance, with the entropy production term. In Eq. (63) of this chapter chemical affinity A appears defined (as in earlier sections) subject to the convention that the affinity is positive when the reaction proceeds from left to right. Unfortunately, however, in an unnumbered equation above Eq. (63) the chemical reaction term is obtained with an incorrect sign, and this error is repeated in the subsequent work, causing misunderstandings.

Chapter 5 deals with (nonequilibrium) entropy and exergy. Outlined are principles of the exergy balance, and the (Gouy-Stodola) law is recalled which links the exergy degraded with the entropy production. Approximate equations are given that describe exergies of some special systems, yet without clear specification of underlying assumptions. Preliminary information is given about the role of exergy concept in description of biological systems, calculation of exergy efficiencies and ecological applications of exergy, to characterize depletion of natural resources.

Chapter 6 continues the application of the second law of thermodynamics by presenting examples with convection and heat flow in ducts and packed systems, where minimizing the entropy generation leads to information about the optimum size of equipment. In particular, heat and mass exchangers are analyzed, and Tondeur's and Kvaalen's "principle of equipartition of the entropy production" or related "equipartition of forces" (uniformly distributed entropy generation rate or uniform forces) is discussed in some detail. The equipartition of forces is not properly explained and, perhaps, not properly understood. This is not a surprise because no such thing exists, except for some strictly linear systems. In fact, as proved by Eqs. (90) and (95) of the chapter, even for the simple process of Fourier heat conduction it is rather grad(lnT) or T^{-1} gradT than grad T itself that is constant along an optimal path. Summing up, one must be contented that at least the final result of the analysis based on the literature material (Tondeur's and Kvaalen's publication [54]) is presented in a correct form. Chemical reactions, reacting flows and separation operations are next analyzed following a group of (sloppy or incorrect) approaches whose purpose is the extension of (correct) Tondeur's and Kvaalen's principle to nonlinear processes. These approaches principally follow the group of research papers written by Sauar and Ratkje-Kjelstrup and their coworkers, refs. [33,39,40].

In Chapter 7, thermoeconomics is introduced. Distinction between purely thermodynamic optimization and approaches leading to thermoeconomic optima is analyzed. Availability and exergy destruction number are discussed in the context of exhaustion of nonrenewable resources and ecological costs. Equipartition and optimization are treated following the techniques similar to those applied in Chapter 6.

In Chapter 8, molecular diffusion phenomena are treated with the help of Maxwell-Stefan frictional model. Next, diffusion in non-electrolyte systems is compared with diffusion in electrolyte systems. For those latter, the role of chemical potentials of electroneutral combinations and the Gibbs equation written in terms of electrically neutral species is pointed out. Irreversible processes in electrolyte systems are described in terms of electrochemical affinities along with diffusion and conductivity coefficients, transferrence numbers and corresponding mobilities. In Chapter 9, coupled processes of heat and mass transfer are treated along with classical issues such as thermal diffusion (Soret effect) and the Dufour effect of the heat flow caused by a concentration gradient. Heat of transport, entropy of transport and degree of coupling are defined. Coupling in binary liquid mixtures is extensively treated with special attention paid to the L Rowley experiments.

Chapter 10 deals with thermodynamic aspects of chemical and biochemical reactions. Again, within the same chapter, some formulas are correct for chemical affinities defined positively [eg, Eqs. (1), (12), (13)], and the others—for affinities defined as negative quantities [eg, Eqs. (2) and (3)]. Still they are formulas in which both conventions of *A* must be used to make them correct, see, eg, Eq. (10) and Eq. (42) supplemented by the affinity definition below that is inconsistent with it. Very nice for true lovers of thermodynamics! Dissipation for chemical reactions, Michaelis-Menten kinetics and coupled chemical reactions can still be considered.

In Chapter 11, the classical information on membrane transport is based primarily on the research of Katchalsky and his coworkers. Passive transport, electrokinetic effects, facilitated transport and active transport are reviewed. Chapter 12 brings valuable newer information on thermodynamics and biological systems. It describes mitochondria and related bioenergetics, oxidative phosphorylation, and identification of proper pathways in a vicinity of reference steady states far from equilibrium. Further information is on multiple inflection points, coupling in mitochondria, Stucki linear approximation, coupling variation, and thermodynamic regulation in bioenergetics. Considerable portion of the text is devoted to facilitated transport, active transport, molecular evolution, and molecular machines. Classical evolutionary criterium is linked with Tellegen's theorem known for network systems. Chapter 13 discusses some other thermodynamic approaches amongst of which are network thermodynamics with bond graph, mosaic nonequilibrium thermodynamics and rational thermodynamics.

Chapter 14 is devoted to extended nonequilibrium thermodynamics, yet the thermodynamic stability conditions it adduces are classical. It also outlines ordering in physical and biological structures and bifurcations in Bernard cells. Extended nonequilibrium thermodynamics in the commonly understood sense, ie, as the theory based on the Gibbs equation extended by the presence of dissipative fluxes, is considered in the last section of the chapter.

In recent decades, thermodynamics has attained a remarkable level of competence in advanced design of practical devices, complex energy and industrial systems, bioprocesses, chemical reactors, reacting flows, separations, and even (most recently) flying objects. One of the key concepts of nonequilibrium thermodynamics is that it can take account of dynamic behavior and pathwise constraints. Some recent developments in thermodynamics, aimed at extending the range of its application to far-from equilibrium regimes (extended thermodynamics, only briefly discussed in the book) abandon the assumption of local equilibrium. Consequently problems in nonequilibrium thermodynamics are formulated as typical or extended macroscopic problems of thermodynamic networks or fields. New developments consider also various aspects of material structure, in particular polymeric fluids and rheological bodies described by general rheological equations of state and bodies with continuous spectra. Still other developments stress similarities of the field with the theory of bifurcating and chaotic systems. In the last decade, an intense activity has been modifying and improving our understanding of statistical mechanics and thermodynamics, and extending its applicability to small and nonextensive systems, systems exhibiting violations of the standard ergodic and mixing properties, or other anomalies. Also, important developments in the connection between statistical mechanics and dynamical systems theory have produced a new understanding of the properties of macroscopic systems. In fact, none of these newer topics is discussed in the book in question. The book represents one of traditional approaches; it describes phenomena at macroscopic level leaving out some recent evergreen problems such as catastrophes, statistical disequilibria and chaos, although many applications can be found there as well. In spite of all its shortcomings, the book reviewed is one of a few books on nonequilibrium phenomena written to date that penetrates the subject matter in a simple way, yet giving a broad overview of contemporary applications.

Nonequilibrium Thermodynamics is the one of the rare books to provide a vast treatment bringing together many advances in the applications within the field. The treatment is largely self-contained and provides a unified perspective on those applied problems which are beyond the realm of conventional analytical and computational techniques of engineering sciences. Moreover, this treatment includes many of the unifying properties and simplifications discovered in recent research. *Nonequilibrium Thermodynamics* summarizes these new applications of thermodynamics as tools that can be used in thermodynamically optimal designs and in understanding diverse phenomena in natural processes.

As scientific rigor is not a basic virtue of this book, the number of errors, inconsistencies, and typos is remarkable. *Nonequilibrium Thermodynamics: Transport and Rate Processes in Physical and Biological Systems* is not free of flaws, but it is an ambitious, inspiring and timely book, a treatise giving a broad overview of nontrivial applications available to date only in research papers, a book which may be read by researchers and graduate students interested in concise presentation of the theory and exhaustive treatment of applications, including those in biological systems. The book is well edited in terms of organization, technical writing, and the use of illustrations; it is also attractively printed. As this is a book of considerable didactic quality, in spite of its shortcomings, it is worth reading.

7N22. Rockets: Two Classic Papers. - RH Goddard *((Deceased))*. Dover Publ, Mineola NY. 2002. 128 pp. Softcover. ISBN 0-486-42537-1. $11.95.

This book is comprised of two papers Robert H Goddard wrote for the Smithsonian Institute many years ago. Said to be among the most significant publications in the history of rockets and jet propulsion, these Smithsonian articles—the first published in 1919 and the second in 1936-were issued at a time when little was known about these subjects. Goddard's first paper, ''A Method of Reaching Extreme Altitudes,'' addressed the theoretical possibility of achieving great ranges by means of well-designed rockets. It also demonstrated that fairly high jet velocities were attainable and described advances in the construction of a solid cartridge magazine-type rocket. The second paper served as a progress report and indicated what had been accomplished through experimentation.

This book is an unabridged republication of *Rockets: "A Method of Reaching Extreme Altitudes and "Liquid-Propellant Rocket Development,"* originally published by the American Rocket Society, New York, in 1946.

Boundary Element Method for Heat Conduction: With Applications in Non-Homogeneous Media. Topics in Engineering, Volume 44. - EA Divo and AJ Kassab *(Univ of Central Florida, Orlando FL)*. WIT Press, Southampton, UK. Distributed in USA by Comput Mech, Billerica MA. 2003. 245 pp. CD-Rom included. ISBN 1-85312-771-X. $138.00. (Under review)

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. (Under review)

IX. BIOENGINEERING

7R23. Bone Mechanics Handbook, 2nd Edition. - Edited by SC Cowin *(CUNY, New York NY)*. CRC Press LLC, Boca Raton FL. 2001. ISBN 08-493-9117-2. $169.95.

Reviewed by JJ Telega (Inst of Fund Tech Res, Polish Acad of Sci, Swietokrzyska 21, 00-049 Warsaw, Poland).

Bone mechanics belongs to one of the oldest and best-developed fields of biomechanics. It is still being developed, both from the traditional and modern points of view. New trends in bone mechanics owe much to the micromechanics, particularly to homogenization and tissue engineering, as well as to cell and molecular biology.

This impressive volume (over 950 pp), edited by a well-known specialist in bone mechanics, also includes these new developments and trends. It clearly shows that bone mechanics has become a strongly interdisciplinary field of research.

The book consists of six sections, each of which in turn includes several mostly review articles written by various acclaimed authors. The first section is concerned with basic biological aspects of bone including some molecular techniques applied to measure skeletal gene expression. The following topics have been discussed: *i*) integrated bone tissue physiology: anatomy (WSS Jee), *ii*) cell biology of bone (RJ Majeska), *iii*) molecular biology techniques to measure skeletal gene expression (MF Young and SC Dieudonné), *iv*) creating transgenic mice to study skeletal function (MF Young and T Xu), and *v*) bone mineralization (AL Boskey). To grasp the content of Section I the reviewer had to study a book on molecular biology and biochemistry first.

Section II opens with a paper by SC Cowin on basic notions of the mechanics of materials presented at the simple and lucid level of strength of materials. Two subsequent papers (one by CH Turner and DB Burr, another by GSP Fritton and CT Rubin) deal with testing methods applicable to bone as a structure and material. Micro- and nano-testing, as well as acoustic tests, have also been concisely described. Bone has a hierarchical architecture, and an important problem is to perform tests on single lamellae and trabeculae. In bone mechanics not only human bones are tested, but a lot of research has been devoted to animal models for biomechanical tests. Advantages and disadvantages of tests performed on animals are briefly discussed. Of the other two experimental papers mentioned, the second one deals with the development of strain gauges for use with bone and tabulates the *in vivo* strain measurements recorded over the years to quantify the mechanical loading environment of the skeleton. The tabulated data, obtained by various authors over the years, are of great value. In the last paper of Section II by P Rüegsegger, the available techniques of bone structure imaging are described. The techniques include X-ray, computer tomography (CT), micro-CT, synchrotron-CT, magnetic resonance imaging (MRI), and micro-MRI. Spatial resolution, advantages, disadvantages, and applicability of each of these techniques have been analyzed.

Section III, the longest one, contains 11 papers. The first of them by XE Gao, strongly related to the experimental papers of Section II, is concerned with mechanical properties of the cortical bone and cancellous bone tissue. Microindentation and nanoindentation tests used to characterize the bone tissue properties have also been characterized. The second paper, by R Lakes, deals with the bone viscoelasticity, a topic always somewhat controversial. The author claims that the physical cause of viscoelasticity is, at least partially, due to fluid flow in a porous material like bone and to interfaces such as the cement lines (the biological significance is not known). The authors of some of the previous papers claimed that cement lines contribute to plastic (time-independent) behavior of wet bone. The unanswered question is: is the mechanical behavior of cement lines time-dependent or time-independent? In the subsequent paper, E Lucchinetti reviews some approaches to macroscopic bone modeling where bone is treated as a composite. For instance, consider a bone as a two-phase material. This is an old problem in the mechanics of composites and micromechanics. The author has reviewed older approaches, like those due to Voigt and Reuss, as well as newer ones proposed by biomechanicians. Unfortunately, vast possibilities offered by modern micromechanics, homogenization, and bounding techniques have not been exploited except for a contribution on reiterated homogenization. (This reviewer and his coworkers wrote many papers on application of homogenization methods to bone modeling See the relevant papers in *Acta Bioeng. Biomech*, Vol 4, Supplement 1, 2002—*Proc of 13th Conf of Europ Soc Biomech*, September 1–4, 2002, Wrocław, Poland). In a subsequent paper, Lucchinetti reviews the results concerning the increasing evidence that the mechanical properties of the bone depend not only on its microstructure, but also on the molecular structure of the organic and inorganic components.

Three subsequent papers are exclusively devoted to cancellous bone. The purpose of the first paper, by A Odgaard, is to overview available methods for quantification of the architecture of cancellous bone. Only the methods applied to histological sections and 3D reconstructions have been discussed. The author claims that "The trabecular arrangement in cancellous bone is obviously not random" and provides some arguments for this. His arguments prove the contrary: the cancellous bone architecture may be viewed as random and described by using the geometry of random fields. The second paper, by B van Rietbergen and R Huiskes, is concerned with the anisotropic behavior of cancellous bone and how it is related to its microstructure. Particular emphasis has been placed on micro-finite element analyses, unfortunately requiring usage of supercomputers. It has been shown that orthotropy is a good approximation for cancellous bone. Relationships based on fabric tensors have also been discussed. In the third paper, TM Keaveny overviews the strength properties of trabecular bone and identified areas where unresolved problems and gaps exist. The strength criterion usually used in trabecular bone mechanics is the Tsai-Wu criterion, primarily developed for fiber-reinforced composite materials. In fact, this criterion should be called Hoffman criterion (see Jemioło and Telega, Fabric tensors in bone mechanics, *Engineering Transactions*, **46**(1), 1998, pp 3–26.

The following papers are concerned with damage in bone. The first of them, by KJ Jepsen, DT Davy and O Akkus investigates three complementary methods of characterizing damage in bone: the process of damage based on property degradation, the physical characterization of damage via histological and histomorphometric means, and real-time characterization of damage based on AE (accoustic emission). Explaining residual strain the authors have not stressed the important role played by anisotropy, inhomogeneity and remodeling. The paper by TD Dwight and KJ Jepsen provides an overview of model suitable for modeling bone damage. The models discussed include also fatigue damage and micromechanical models. Unfortunately, damage and repair models, important for the description of bone remodeling, have been limited to one-dimensional models.

The second to last in Section II (by JD Currey) provides some answers related to ontogenetic changes in (mainly) compact bone material properties. The discussion ranges from fetal bone to senescent changes and clearly shows that a lot has to be done to better grasp this aspect of bone behavior. The last paper in this Section RB Martin and NA Sharkey reviewes three topics: *i*) postmortem changes in mechanical properties of bone (for instance, influence of cell death), *ii*) the mechanical effects of preserving bone (freezing, chemical preservation), and *iii*) the mechanical effects of storing and treating allograft bone (lyophilization, irradiation, methanol and chloroform treatment, thermal sterilization).

Section IV includes five papers on various aspects of fluids flow in bone. The physiology of blood flow in bone is reviewed by H Winet. More precisely, the author discusses the vascular levels, typical for blood circulation: arteries→arterioles→arteriolar capillaries→capillaries→venular capillaries→venules→veins. Next, ML Knothe Tate focuses her review on various aspects of interstial fluid flow, including molecular transport mechanism in bone. This paper is somewhat complementary to the subsequent article by Cowin who reviews possible application of poroelasticity to flow of bone fluids. Among many aspects of this flow, it is worth noting that poroelasticity and electrokinetics can be used to explain strain-generated potentials in bone. The article by SR Pollack synthesizes the historical perspective of the passage from piezoelectricity to streaming potentials (in wet bones) and discusses current views on electrokinetics in living bone. It is now commonly believed that just electrokinetics is the underlying phenomenon accounting for the mechanoelectric observations in bone at frequencies less than 10^6 Hz. In the last paper of Section IV, YP Arramon and EA Nauman discuss lucidly the various terms, theories, and conventions used in the study of the permeability within the context of fluid flow through cancellous bone.

Section V, comprising seven interrelated papers, is concerned with a very broad spectrum of bone adaptation problems: from cell level to macroscopic modeling. In the first paper, AE Goodship and JL Cunnigham discuss the role of the genetic component and mechanical loads as well as transduction pathways in bone remodeling. It seems that we still lack mathematical models incorporating the component mentioned. In the next paper, TD Brown reviews the instrumentation and protocols that have evolved for *in vitro* mechanostimulus testing of bone cells, for instance hydrostatic compression, direct platen contact, substrate distension or bending fluid shear and combined stimuli. The subsequent two papers, the first by EH Burger and the second by SC Cowin and ML Moss, deal with mechanosensitivity and mechanotransduction phenomena in bone. Though many aspects remain purely speculative, the role of osteocytes in the mechanosensory process has been established experimentally (Burger). Severe criticism of what came to be known as ''Wolff's law'' has been provided by SC Cowin. This author traces back the original development of functional adaptation of bone to loading and provides purely static arguments why the trajectorial theory is false. A review (not exhaustive) of models describing functional adaptation of cortical and trabecular bones is provided by RT Hart. In the reviewer's opinion, most of the available models are just modifications and possibly extensions of the adaptive elasticity model (viscoelasticity may be treated similarly). In the subsequent paper, PJ Prendergast and M van der Meulen review the biology of bone healing and the theories that describe the regulation of bone regeneration by mechanical forces.

The last section entitled ''Clinically related issues'' consists of four papers. In the first paper, ML Villarga and CM Ford synthesize the state-of-the-art in the understanding of hole-bone mechanics, and in particular as it relates to whole-bone fracture. Next, JJ Kaufman and RS Siffert discuss methods for noninvasively measuring skeletal integrity (X-ray densitometry, ultrasonic techniques, micro-CT, MRI). In the subsequent paper, Prendergast shows that replacement or augmentation of bone by prostheses has led to a prolific number of devices with one common aim—to alter the load transfer in bone fissue. More precisely, this author briefly discusses biomaterials used for replacement of bone in the human body (metals, ceramics, and polymers), design of bone prostheses, analysis and assessment of implants including preclinical tests and clinical data. The last paper in this book, by SJ Hollister, TMG Chu, JW Halloran and SE Feinberg, summarizes current work on scaffold design and fabrication for bone tissue engineering. The authors discuss three topics: design, fabrication, and overall concept from design to *in vivo* testing.

This reviewer really enjoyed reading Cowin's book, though it is by no means self-contained, particularly in respect to notions from genetics and molecular biology. If a third edition of the book is planned, this reviewer suggests publishing the book in two volumes and include a comprehensive chapter on indispensable ideas and notions from biology, genetics, and molecular biology. Having read the book, the reader still will have no clear idea what terms, such as *plasticity* and *yielding* really mean, unless he is well acquainted with metal plasticity. Despite this, the amount of valuable material and often tabulated data is strikingly enormous. The book is well balanced and covers almost all currently important aspects of bone mechanics. Existing controversies and indications for future research are discussed in many of the papers. This reviewer strongly recommends *Bone Mechanics Handbook, 2nd Edition* to biomechanicians, not only to those interested in bone mechanics. Since the mechanical aspects of bone behavior have been presented in a lucid manner, the book will also be very useful to biologists and biophysicians involved in bone research. Having in mind the rich contents of the book, its price is by no means elevated.

X. GENERAL & MISCELLANEOUS

7N24. Rational Continua, Classical and New: A Collection of Papers Dedicated to Gianfranco Capriz on the Occasion of his 75th Birthday. - Edited by P Podio-Guidugli *(Univ di Roma Tor Vergata, Roma, Italy)* and M Brocato *(IEI-CNR, Area della Ricerca di Pisa, Pisa, Italy).* Springer-Verlag, Berlin. 2003. 207 pp. ISBN 88-470-0157-9. $69.95.

This book contains 16 research papers written by world-leading scientists in the field of continuum thermomechanics. The authors discuss a number of different theories, both classical and new. The underlying general theme is the exploration of the limits of the continuum approach, as it was consolidated between the late 1050s and the early 1970s, as well as the study of those amendments and extensions that would mathematically treat a host of real-life problems that have been proposed, but not yet adequately modeled, within materials science, structural optimization, biosciences, medical engineering, and superconductivity.

Author Index for July 2003

The codes after each name give the sequence numbers of the items in the Book Reviews section (R = Review, N = Note). Books listed by title only or as "under review" are not included in this index.