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. [DOI: 10.1115/1.1470665]

I. FOUNDATIONS & BASIC METHODS

5R1. Constitutive Modelling of Geomaterials. - Edited by B Cambou *(Laboratoire de Tribologie et Dynamique des Syst, Ecole Centrale de Lyon, 36 Ave Guy de Collongue, Ecully Cedex, 69131, France)* and C Di Prisco *(Politecnico di Milano, Piazza Leonardo da Vinci 32, Milan, 20133, Italy)*. Hermes Sci Publ, Paris. 2000. 233 pp. Softcover. ISBN 1-903398-06-1. $74.95.

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

This monograph consists of seven lectures, written by nine specialists of geotechnique, emphasizing their fields of interest and thought as an advanced course to engineering students at the graduate level. The lectures are consecutively arranged and hinge upon one another, but are equally independently readable each with its own reference list. Cross references are loose, and no index is provided.

Apart from an editorial (F Darve), Chapter 1 (R Chambon) provides a "General presentation of constitutive modeling of geomaterials" on the basis of continuum mechanics and geared to the application of the finite element method. The lecture browses through the principle of virtual power; touches many material peculiarities such as cyclic, viscous and relaxation effects, localization, and rupture; culminates in Section 4 in the well-known terminology of the *Nonlinear Field Theories of Mechanics* by Truesdell and Noll; and terminates in stating well posedness (in the sense of Hadamand). The presentation is colloquial, shallow in depth with occasional slips in the English language, perhaps useful as a source of references.

Chapter 2 on "Continuum damage modeling" (G Pijandier-Cabot) is restricted to elasto-plasticity and its change of properties under microstructural degradation. First, elasto-plastic damage and crack closure effects are described; then an internal length is incorporated providing a failure model that is consistent with fracture mechanics and paving the route to induced anisotropic behavior. Finally, environmentally-induced damage effects are discussed. The concepts are simply and clearly introduced, and the scope is limited to the description of damage phenomena in concrete.

Chapter 3 provides an introduction into "Incrementally nonlinear modeling" (F Darve and X Roguiez), a subject pioneered by the principal author. The key idea is to express the strain increment as a function of the stress increment in a rate independent fashion or vice versa. For a quadratic dependence of the strain increment upon the stress increment, elasto-plastic tangent moduli are constitutively prescribed for which two formulations having only five phenomenological parameters are presented. These are determined with typical oedometric tests, and the final model is then applied under uniaxial extension and compression to study questions of material instability. The text is brief and assumes detailed advanced knowledge of the reader.

Chapter 4 presents a comprehensive introduction into the "Elements of hypoplasticity" (D Kolymbas). The author carefully introduces notions such as elasticity, elastoplasticity, and hypoelasticity and culminates in the presentation of the general form of a hypoplastic constitutive model as an equation relating the Jaumann stress rate as a nonlinear functional of the stress and stretching. It is shown that this functional needs to be nonlinear and rate independent in the stretching to capture typical soil behavior. A particular formula is shown, and questions of parameter identifications are touched. The author also addresses points of weaknesses that have so far been observed with hypo-plastic constitutive relations and gives a review of proposed hypoplastic equations. The chapter is thoughtfully written and adequate for students to learn the subject.

"Constitutive equations in plasticity" (C die Pricso and M Pastor), in Chapter 5, provides a comprehensive account of elastoplastic constitutive modeling with yield surface from a theoretical as well as experimental point of view. Perfect plasticity with Tresca, Mises, and Mohr-Coulomb failure surfaces and single potential hardening plasticity are discussed as is (induced) anisotropy. The concepts of cyclic loading, kinematic hardening densification, and liquefaction of sand are equally touched upon. Further sections are devoted to viscoplasticity and damage and instability in load-controlled tests—a subject still under intensive debate. The chapter is long (57 pages), well written and attempts to provide a balanced review, but unfortunately does not give an abstract.

The scope and spirit of Chapter 6, on "Higher order constitutive models" (I Vardoulakis), is somewhat different from the remaining contributions as it is the only one using higher-order gradient models. By way of illustration, second gradient theories account for local curvature effects; so an internal length scale is naturally introduced. Using beams as an illustration, the author then presents Mindlin's 2nd gradient linear elasticity theory before he introduces the gradient plasticity model for granular materials. These formulations necessarily require the introduction of surface double forces which are carefully introduced. It is further demonstrated that shear band localization and cavity collapse can naturally be described with such formulations and that the boundary layer thicknesses are directly connected to the internal length scale.

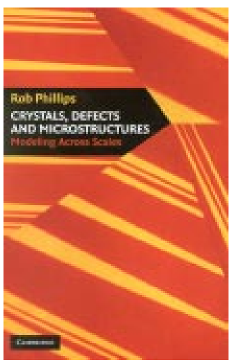
Chapter 7 deals with "Constitutive modeling of granular materials from a change of scale" (B Cambou). Its subject is homogenization, ie, the transfer of the properties of the grains and their interaction to the macroscale of which a typical length is several grain diameters. By way of introducing local variables such as void ratio, coordination number (ie, average number of contacts per particle) fabric tensors, and applying rules defining the macroscopic stress tensor in terms of contact forces and contact orientations, macroscopic stress relations can be derived, provided that rules are also given which define the macroscopic kinematics in terms of the microscopic deformations. Several models are presented, and their performance is covered briefly. The presentation is brief, but clear and provides an acceptable introduction into quasistatic (mostly) linear behavior.

As for the printing, the book could have been more carefully edited. There is much better software available in which formulas appear in better form. Figures have varied style and inset texts are often hardly readable; equally, captions are often insufficient. Whereas all authors write in acceptable English, a more careful devotion to the text by the copy editor would have eliminated occasional slips and unified the style. As a whole, *Constitutive Modelling of Geomaterials* is useful for upper-level students and researchers to obtain an impression about present day constitutive modeling of geomaterials with a fairly extensive reference list.

5R2. Crystals, Defects and Microstructures: Modeling Across Scales. - R Phillips *(Brown Univ, Providence RI)*. Cambridge UP, Cambridge, UK. 2001. 780 pp. Softcover. ISBN 0-521-79357-2. $47.95.

Reviewed by MS Kuczma *(Inst of Civil and Env Eng, Univ of Zielona Gora, ul Podgorna 50, Zielona Gora, 65-246, Poland).*

This is an invaluable book devoted to the modeling of crystalline materials at different scales. The ultimate Phillips's aim has been to show the origins of approximate, effective theories of material behavior and how to build such theories that are capable of capturing complex problems involving either multiple length or time scale simultaneously. The book has mixed character, alternating between text and monograph mode, with the same idea presented from a number of different perspectives. The author's purpose is to present ideas rather than to give an exhaustive description of so many alternative concepts and approaches discussed in the book. Thus, as a prerequisite on the part of the reader, some working knowledge in the fields of physics of solids, continuum mechanics, and differential calculus will be helpful in order that she or he could better focus on the principle thrust of discussions and derivations.



The text is divided into 13 chapters that are grouped in four basic parts. Part I, which is entitled *Thinking About the Material World*, consists of three chapters and provides an overview of the fundamental ideas that are useful in describing material response and in revealing the link between structure and properties. In particular, emphasis is placed on the notion of material parameter, the significance of phase diagrams to materials science and the role of lattice defects. Next, basic concepts of continuum mechanics are introduced and used in continuum descriptions of deformation and failure. The principle of minimum potential energy is formulated for linear elasticity, and the finite element approach to the corresponding boundary value problem is sketched. Part I ends with a revision of quantum and statistical mechanics. Here, solution of the Schrödinger equation is illustrated for a number of cases, including that of the hydrogen atom and the so-called electron gas model, with the aim of demonstrating the analogy between the problem of coupled oscillators and that of bonding in molecules. Finally, statistical mechanics of the Ising model and that of electrons is briefly described.

In Part II, *Energetic Description of Cohesion in Solids*, the total energy of the system is the starting point for analysis of material behavior. The energy is obtained on the basis of the kinematic measures that can be used to characterize the system's geometry. On the grounds of microscopic theories, the total energy is a function of the atomic coordinates, whereas in a continuum description the energy is postulated to be a function of the relevant strain measures. The author gives examples of broad classes of total energy functions evaluated from the microscopic perspective, both with a direct incorporation of the electronic degrees of freedom and also their effective representation through the electron density. Starting from the Hamiltonian for a system of interest, which embodies the motions and interactions between all the nuclei and electrons in the system, Phillips explains the logic behind systematic degree of freedom elimination. He exploits the so-called Born-Oppenheimer approximation and constructs some simplified description in terms of effective pair potentials. He also discusses some difficulties with the pair potential description and remedies to cure some of them in the form of potentials with environmental and angular dependence. Further, the tight-binding method is described and its particular realization in the context of periodic solids as so-called *k*-space methods is illustrated, invoking Bloch's theorem. Also, the density functional theory and the corresponding Kohn-Sham equations are sketched.

Chapter 5 is concerned with the energetics of both thermal excitations and elastic deformations of crystals. The author shows how the energy methods in conjunction with statistical mechanics can be used in predicting the material properties including the specific heat, thermal expansion and elastic moduli. An interesting analysis of normal modes and phonon dispersion relations is carried out, including the passage to the vibrational density of states. Further, the microscopic derivation of the elastic moduli concept is demonstrated primarily for a generic linear case and with some extension to nonlinear elasticity (the Cauchy-Born rule), linking atomistic models to continuum fields. Chapter 6, which closes Part II, discusses realization of distinct competing crystal structures in the context of elemental and alloy phase diagrams. The issue of structural stability is illustrated by predictions of a number of free energy functions constructed on various levels of sophistication invoked, including an Einstein model for structural change, cluster expansions and the cluster variation method.

Part III, *Geometric Structures in Solids: Defects and Microstructures*, deals with the various types of defects that populate materials, ranging from point defects (Ch 7) and line defects (Ch 8) to interfacial defects (Ch 9). An analysis of point defects is carried out from both a microscopic and continuum perspective with emphasis being placed on their origins and motion, and also consequences they have on the ultimate macroscopic properties of materials. The process of diffusion is examined, and some effective theories of diffusion are advanced.

Chapter 8 considers dislocations from the perspective of their role as the primary agents of plastic deformation. Both discrete and continuous descriptions are developed. The equilibrium fields associated with typical dislocations are studied within the linear theory of elasticity, which forms the foundation for analysis of interaction energies and configuration forces on dislocations (Peach-Koehler's formula) and of the Peierls-Nabarro model. Finally, three-dimensional dislocation configurations are discussed, including the cross slip, kinks, and dislocation junctions. Chapter 9 focuses on two-dimensional wall defects (surfaces, stacking faults, grain boundaries) and serves as the basis for the consideration of microstructures within materials. The author highlights their role in producing confinement in the context of elastic waves, mass transport, and plastic action. The notion of an interfacial energy and that of a surface reconstruction are defined and exemplified in a number of representative cases. Chapter 10 analyzes some types of microstructures that exist in materials. First, the author discusses a considerable diversity of microstructures and a possibility of their production by appropriate processing strategies, and what the consequences of such microstructures are to the underlying physical properties of a material. The solution the Eshelby inclusion problem is derived and used in investigating the equilibrium morphologies of second phase particles. Also, the issue of temporal evolution of two-phase microstructures has been considered. Special attention is given to the realization of the compatibility condition in the context of martensitic microstructures. In the consideration of grain growth in polycrystals, the author has made use of the Potts model, phase field models, and sharp interface models.

Part IV, *Facing the Multiscale Challenge of Real Material Behavior*, constitutes the culmination of preceded developments discussed in the book with the aim to build effective theories based on a reduced set of degrees of freedom. Chapter 11 concerns a mutual interplay between the different types of defects defined earlier. Three groups of problems are considered: diffusion, mass transport assisted deformation, and dislocation-grain boundary interaction. In particular, these include exchange mechanisms for surface diffusion, Nabarro-Herring and Coble mechanisms for creep and the Rice model of dislocation nucleation at a crack tip, and the phenomenon of hardening approached from various perspectives.

Chapter 12 is a crowning part of the book, being explicitly devoted to the problem of bridging scales and effective theory construction. Here, Phillips revisits his previous considerations and generalizes the philosophy behind multi-scale modeling. Indicating to a tradition of multiscale approach, the author records some historic examples of multiscale modeling. He discusses cohesive surface models and mixed approaches in which constitutive models of different sophistication (hierarchical structure) are used, eg, a conventional continuum model in a region far from defects (cracks, dislocations), whereas in the immediate vicinity of defects a more refined analysis pertinent to subscales. In the format of gradient flow dynamics, variational derivations of the Allen-Cahn equation which describes the spatio-temporal evolution of a non-conserved order parameter field, and the Cahn-Hillard equation for such evolution of conserved fields are obtained. He shows how to create a family of effective Hamiltonians by the renormalization procedure and indicates the Monte Carlo method and hyperdynamics methods as a scheme for the hierarchical treatment of diffusive processes, raising the question on how to connect the notion of temperature and time. Phase field models are invoked in the context of both solidification and phase separation, and the finite element interpolation and its consequences in elimination of atomic degrees of freedom. Finally, in Chapter 13, the author has collected his reflections on the universality and specificity in materials and posed a series of intriguing open questions.

The presentation of this difficult and complex subject matter is organized in an accessible and attractive fashion, being pedagogically well balanced as concerns both the level of detail discussed and the notations used. It contains a lot of enlightening descriptions of the current theoretical concepts and many case studies. The included graphical illustrations of numerical results and of experimental findings substantiate the theoretical constructs and, in addition to that, will be provocative to the perspicacious reader. Each chapter closes with a useful section, *Further Reading*, and a set of problems to solve, which are related to the topics discussed in that chapter. There is a single list of references and a subject index at the end of the book.

A careful reading of the entire book shows that the text is well edited; this reviewer spotted only a few misprints. The various chapters can be read independently, but the logic of the book is intertwined, so in order to better appreciate the message conveyed the book should be treated as a single entity. Although the book is written in the narrative style that may be found by some readers a bit lengthy at times, this reviewer appreciates much the author's extensive vocabulary.

Phillips has undertaken a very difficult and venturesome enterprise to write a book that encompasses such a wide spectrum of different concepts and issues under one roof. One of the key features this reviewer enjoyed in reading the Phillips' book is his willingness to explain how macroscopic behavior is built up from microscopic motions, and that there are problems where a proliferation of scales both in space or time (or both) should be accounted for simultaneously. This reviewer believes that the value of this book is in that, on the one hand, it substantiates the need for a multiscale approach and, on the other hand, presents a framework for a mechanism of the information passage from the microscopic scales to those associated with macroscopic observables. It should be noted that the author reveals not only the strengths of various theoretical models, but also their limitations, and shows that the important *nonconcepts* like nonlinearity, nonlocality, and nonconvexity single out intriguing features of material behavior. For example, nonconvexity implies the existence of multiple wells, whereby admitting of the emergence of complex microstructures. The discussions in this book support this reviewer's conjecture that the hierarchical modeling via mixed atomistic/continuum models will become the subject of intensive research in the years to come. This kind of approach is in accord with the adage that *one should think globally and act locally*. One of the critical issues that emerges here is how to effectively control the modeling error in quantities of interest, so that we could determine the proper interfaces and their location which will separate regions where models of different sophistication could be employed within a preset tolerance.

Phillips' *Crystal, Defects and Microstructures* makes for most instructive reading. This reviewer very strongly recommends it for graduate students and researchers in science and engineering who wish to gain understanding of the theoretical constructs in the study of materials.

5R3. Finite Element Solution of Boundary Value Problems: Theory and Computation. Classics in Applied Math, Vol 35. - O Axelsson *(Univ of Nijmegen, Nijmegen, Netherlands)* and VA Barker *(Tech Univ, Lyngby, Denmark)*. SIAM, Philadelphia. 2001. 432 pp. Softcover. ISBN 0-89871-499-0. $50.00.

Reviewed by DJ Benson (Dept of Appl Mech and Eng Sci, UCSD, 9500 Gilman, La Jolla CA 92093-0411).

Quoting from the preface, ''The purpose of this book is to provide an introduction to both the theoretical and computational aspects of the finite element method for solving boundary value problems for partial differential equations.'' Its intended readers are advanced undergraduates and graduate students in numerical analysis, mathematics, computer science, and the ''theoretically inclined workers'' in engineering and the physical sciences. In comparison to some recent texts, the book is short at 432 pages, but the topics the authors decided to treat are treated thoroughly.

The first chapter is devoted to quadratic functionals on finite-dimensional vector spaces. Chapters 2 and 3 discuss the variational formulation of boundary value problems, and Chapters 4 and 5 discuss the Ritz-Galerkin and the finite element method. Some readers may be disappointed to find that the text does not present a catalog of all the common interpolation functions that are currently in popular use, or address h-p methods, but these are minor quibbles. The final two chapters cover direct and iterative methods for solving the linear equations generated by the finite element method. The last chapter also includes an introduction to the multigrid method. Exercises and references are provided at the end of each chapter. The text is independent of any particular programing language, which is a nice feature. Some of the algorithms are written out in a form of pseudocode that anyone familiar with any computer language should be able to read.

Because the book suits the interests of students in numerical analysis and mathematics so well, the majority of mechanical engineers will probably not be interested in this text. Most of the partial differential equations are model linear ones, and the challenges associated with beam, plate, and shell elements are largely ignored as are all nonlinear problems. In addition, it does not address the issues of selective reduced integration and other *variational crimes*.

In terms of its stated aims, the book is a success. It is mathematically rigorous, yet does not become bogged down in either ponderous notation or the details of arcane points that are of little interest to the reader new to finite element methods. The explanations are clear and, for its intended audience, it should be a good read. This book, *Finite Element Solution of Boundary Value Problems: Theory and Computation*, will appeal to readers who have enjoyed the books by Ciarlet, Claes Johnson, and Oden.

5R4. Handbook of Continuum Mechanics: General Concepts, Thermoelasticity. - J Salencon *(Lab de Mec des Solides, Ecole Polytechnique, Palaiseau Cedex, 91128, France)*. Springer-Verlag, Berlin. 2001. 803 pp. ISBN 3-540-41443-6. $159.00.

Reviewed by S Bechtel (Dept of Mech Eng, Ohio State Univ, 206 W 18th Ave, Columbus OH 43210-1154).

This book, translated by Stephen Lyle from a 2000 French edition, is part of a series of English translations of textbooks developed by the Ecole Polytechnique for its students. It is a handbook in the sense of an encyclopedia, providing a complete and detailed reference source for the concepts behind continuum mechanics and its specializations to thermoelasticity and one-dimensional media.

The physical quality, including typesetting and figures, is outstanding. The book's 803 pages are divided into 12 chapters, three appendices, a bibliography, and an index. Each chapter begins with a front page with a title and on the order of ten keywords, a one-page abstract, a table of the important new notation introduced in the chapter, and an outline of the sections and subsections that comprise the chapter, and ends with a summary of the main formulas, and set of exercises, with hints toward their solution. This considerable level of structure and organization of the presentation, together with the many references to related concepts and developments that occur elsewhere in the book both before and after, is intended by the author to simplify the reader's task as much as possible, and also assists in its use as a reference. The presentation is thoughtful: Generally, there is first a conceptual discussion, with appeal to experimental results, before the mathematical discussion, and there is a sensitivity to the multiple scales in physical problems.

The first six chapters present the general theory of continuum mechanics, with the construction of mechanical models and the modeling of forces based on the principle of virtual work. The only constitutive behavior addressed in the book is elasticity, in Chapters 7 through 10. Chapter 11 presents the general static theory of one-dimensional continuum models, which is specialized to thermoelastic structures in Chapter 12.

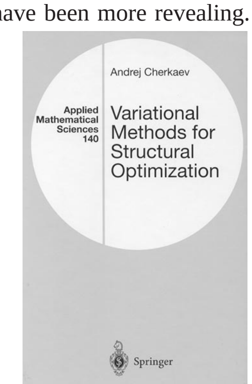
The book is accompanied by a 60-page pamphlet which summarizes the main points in the 12 chapters, and a fold-out one page glossary which translates words and phrases ranging from *acceleration* to *zero line* into French, German, Spanish, Italian, and Portuguese.

This reviewer found in the book familiar concepts presented in unfamiliar settings. The mathematical notation and the appendices devoted to tensor calculus and differential operators are different from what one has come to expect in introductory texts in continuum mechanics and may be beyond many upper-level undergraduate students and lower-level graduate students. This reviewer would be hesitant to employ the book as a text in a first course in continuum mechanics. It is most appropriate as either a text in an upper-level continuum mechanics course or independent study after a first course (if a second course is not available), or as a complete and likely different reference source for someone who has taken the full sequence. The *Handbook of Continuum Mechanics* certainly has value to this reviewer, a teacher of first and second courses in continuum mechanics and thermomechanics, who found in it a fresh take on the conceptual underpinnings of these subjects.

5R5. Variational Methods for Structural Optimization. Applied Mathematical Sciences, Vol 140. - A Cherkaev *(Dept of Math, Univ of Utah, Salt Lake City UT 84112)*. Springer-Verlag, New York. 2000. 545 pp. ISBN 0-387-98462-3. $79.95.

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

This is an excellent book on material and microstructure optimization by one of the world's main authorities on the subject. It is a comprehensive (545 pages) treatment and state-of-the-art review of this area, which is an active field in applied mathematics. The title of the book may be slightly misleading for readers from the engineering community, since the book does not deal with the methods of *classical* engineering structural optimization, on the macro scale. The latter has been the subject of many books, like the collection of papers *Structural Optimization: Status and Promise*, edited by MP Kamat (AIAA, 1993). Cherkaev's unique book is concerned with the microstructure and with questions such as how to distribute the different materials constituting a two-phase or a multi-phase solid in an optimal way. The main practical application of the subject is to the design of composite materials on the micro scale. (The last chapter also touches on composite optimization on the macro scale.) Perhaps the words ''Composite Optimization'' instead of ''Structural Optimization'' in the title would have been more revealing.



The book is divided into five parts, each containing up to four chapters. Part I explains the key problems and ideas in a simple one-dimensional context. It is demonstrated that in some non-convex variational problems, the minimizer suffers from fine-scale oscillations. Then the notion of relaxation via the convex envelope is introduced as a remedy (Ch 1). Conductivity problems (eg, in heat transfer) in composites are discussed, along with the concept of homogenization (Ch 2). A way to find bounds for the effective properties of the composite is shown. The notion of G-closure is defined: this is the set of all the effective properties of all possible composites that can be constructed from the given materials (Ch 3). Part II goes deeper and discusses various approaches to attack some composite optimization problems in conductivity, using the techniques introduced in Part I. First a basic problem is dealt with thoroughly (Ch 4), and then more general problems are discussed (Ch 5). Part III generalizes the concept of relaxation to the multi-dimensional case, first by introducing the notion of the quasiconvex envelope (Ch 6), and then by discussing three different methods (Ch 7–9) for finding upper and lower bounds for this envelope.

Part IV concentrates on methods for finding the G-closure. First the theory is discussed (Ch 10), then it is applied to a few examples (Ch 11), and finally it is extended to problems with more than two materials (Ch 12) and to problems involving dissipation (Ch 13). Part V, clearly the highlight of both Cherkaev's work and the book, discusses optimization of composites in linear elasticity. The theory of inhomogeneous elasticity is outlined (Ch 14), and various optimization problems are solved in a simple case (Ch 15), and in more general cases (Ch 16), by finding bounds for the effective properties. The last chapter (Ch 17) discusses some global optimization problems of elastic composites.

In general, the book is very well written. The exposition is mathematical in nature, but by no means dry. The book includes many illustrations and examples and is certainly accessible to mathematically-oriented readers of the applied mechanics and engineering communities. Not many mathematicians can write in a style which is both rigorous and readable at the same time, and in this, the author has done an important service to researchers in applied mechanics. Cherkaev wisely avoids the treatment of abstract subjects like Young measures. The book is full of up-to-date information on the problems and methods of composite optimization, with reference to a very large number of papers on the subject. Each chapter ends with a short summary and with a few well-designed problems for the reader.

The book could have seen better proofing. This reviewer was amazed to find out that more than half of the entries in the index have wrong page numbers. (There is a shift of 2 in all the page numbers starting from around page 200.) In addition, the page numbers appearing in the Contents are wrong from the middle of Chapter 15. There are also many errors in equation numbers appearing in the text (the first three errors are on pages 5, 6, and 12). This reviewer is sure these errors will be a source of frustration to many readers. It is really a pity that such a book, which is so thorough on the professional level, is less than perfect from the publishing aspect.

Despite this unnecessary deficiency, Cherkaev's book is indeed a very welcome contribution to the field of composite optimization. *Variational Methods for Structural Optimization* is highly recommended to researchers and students interested in the field, and should certainly be added to every library collection of books in applied mechanics.

5N6. Asymptotic Approximations of Integrals. Classics in Applied Mathematics, Vol 34. - *R Wong (Fac of Sci and Eng, City Univ, Kowloon, Hong Kong, China).* SIAM, Philadelphia. 2001. 543 pp. Softcover. ISBN 0-89871-497-4. $77.00.

This SIAM edition in an unabridged, corrected republication of the work first published by Academic Press (1989). Asymptotic methods are frequently used in many branches of both pure and applied mathematics, and this book deals with one important aspect of this area, namely, asymptotic approximations of integrals. Since its publication 12 years ago, significant developments have occurred in the general theory of asymptotic expansions, including smoothing of the Stokes phenomenon, uniform exponentially improved asymptotic expansions, and hyperasymptotics.

5N7. Computational Fluid and Solid Mechanics. Proc of 1st MIT Conf, June 2001, Cambridge MA. - Edited by KJ Bathe. Elsevier Sci Ltd, Kidlington, UK. 2001. 1768 pp. Hardbound. ISBN 008-043944-6. $221.50. (CD, $74; Print and CD, $244).

The two volumes of this proceedings provide a comprehensive guide to the latest research covering Computational Fluid and Solid Mechanics. Additionally, a searchable CD-ROM version of the proceedings has reproduced many of the original figures in full color. There are 446 papers included. The contents of Volume 1 includes Plenary Papers, Solids and Structures, and Optimization and Design. Volume 2 covers Fluids, Multi-Physics, CFD for the Natural Convection Problem, Algorithms (independent of physical applications), an author index, and a keyword index.

5N8. Constitutive Models for Rubber II. Proc of 2nd European Conf, Hannover, Germany, Sept 2001. - Edited by D Besdo *(Inst fur Mech, Univ Hannover, Germany)*, RH Schuster *(Deutsches Inst fur Kautschuktechnologie, Hannover, Germany)*, and J Ihlemann *(Inst fur Mech, Univ Hannover, Germany)*. Balkema Publ, Rotterdam, Netherlands. 2001. 307 pp. ISBN 90-2651-847-1.

Around the topics of phenomenological as well as physically motivated constitutive models for rubber, a wide range of subjects is covered, like softening effects, phenomena related to aging, damage, fatigue, and the influence of cross-linking. Moreover, experimental investigations, numerical methods, identification, and optimization procedures, and also industrial applications are presented.

5N9. Numerical Methods for Experimental Mechanics. - D Berghaus *(Georgia Inst of Tech, Atlanta GA)*. Kluwer Acad Publ, Norwell MA. 2001. 295 pp. ISBN 0-7923-7403-7. $135.00.

This book is a resource to enable engineering mechanics researchers to understand and to obtain a working familiarity with important numerical methods particularly useful in the field. Organized to permit readers to study the methods and to observe their application in experimental problems, it also enables them to directly apply the methods to the same problems or to similar problems of their choosing. Computer programs are available, together with data for easy application. Program listings are given in an appendix.

Some of the topics covered include the following: Least-squares for curve fitting and for general problem solving, Linear and nonlinear least-squares, Weighting; Splines and smoothed splines (for differentiation), General boundary conditions, Controlling the smoothing; Discrete and fast Fourier transforms, Using the DFT and FFT together; Digital filters (single pass and two-pass), Higher-order filters, High-pass filters, Good behavior at ends; and Differentiation and integration of experimental data.

Random Heterogeneous Materials: Microstructure and Macroscopic Properties. - S Torquato *(Dept of Chem, Princeton Mat Inst, Princeton Univ, Princeton NJ 08544)*. Springer-Verlag, New York. 2002. 701 pp. ISBN 0-387-95167-9. $69.95. (Under review)

II. DYNAMICS & VIBRATION

5R10. Encyclopedia of Vibration: Volumes 1, 2, and 3. - Edited by SG Braun *(Fac of Mech Eng, Technion-Israel Inst of Tech, Haifa, 32000, Israel)*, DJ Ewins *(Dept of Mech Eng, Imperial Col of Sci, Tech and Med, Exhibition Rd, London, SW7 2BX, UK)*, and SS Rao *(Dept of Mech Eng, Univ of Miami, PO Box 248294, Coral Gables FL 33124-0624, SW7 2BX)*. Academic Press, San Diego. 2001. 1595 pp. 3-vol set. ISBN 0-12-227085-1. $925.00.

Reviewed by AW Leissa (Dept of Mech Eng, Ohio State Univ, 206 W. 18th Ave., Columbus OH 43210-1154).

The title chosen for this three-volume set of information about vibrations is very appropriate, for it is indeed an encyclopedia, consisting of 168 short chapters, each treating a particular topic, arranged in alphabetical order. The individual chapters are written by persons who are known to be authorities on the topics. Altogether, 132 persons were contributors, writing chapters which are typically 7-12 pages long.

The topics chosen take on a variety of forms. Some of them deal with long-standing vibration concepts (critical damping, dynamic stability, forced response, friction damping, hysteretic damping, etc), some consider types of structural or machine elements (beams, bearings, belts, blades and bladed disks, columns, disks, membranes, pipes, plates, etc), and some are brief summaries of methods of analysis (boundary elements, finite differences, finite elements, Krylov-Lanzos methods, linear damping matrix methods, etc). Current topics of considerable interest (active vibration suppression, actuators and smart structures, electrostrictive materials, laser based measurements, MEMS applications, etc) are also included.

A typical chapter begins by describing the topic, and then defines and explains concepts and the terminology involved. Some interesting and useful results are then usually presented and discussed. Each chapter concludes with a list of publications which are recommended for further reading, for those who want to learn more about the topic.

There is a wealth of useful information contained in this encyclopedia. This is due to not only the size of the compendium (1595 pages, 20×27 cm), but also because each author had to try to condense the most important information into a limited space. It can only be a starting place for a reader interested in any topic, but it is a very good one. One can locate topics easily for, in addition to a complete Table of Contents at its beginning, a 31 page Index of topics and subtopics and their corresponding page numbers is included at the end of each volume.

In the opinion of this reviewer, this three-volume encyclopedia is a collection of information which is very useful for all persons who want to know more about vibrations—students, engineers, researchers, and teachers. Those who can afford it will benefit significantly in having a personal copy. But every engineering library should definitely have it.

5R11. Linear and Nonlinear Rotordynamics: A Modern Treatment with Applications. - T Yamamoto and Y Ishida *(Nagoya Univ, Nagoya, Japan)*. Wiley, New York. 2001. 325 pp. ISBN 0-471-18175-7. $94.95.

Reviewed by RG Kirk (Dept of Mech Eng, Rotor Dyn Lab, Virginia Tech, Randolph Hall - Room 119, Blacksburg VA 24061).

The authors have documented in this text their extensive works and accomplishments in this important field of engineering. The background of the authors original works are explained in the Foreword written by Professor Harold Nelson, a well known and respected researcher in the same field of study and well versed in the total history of rotating machinery analysis.

The first half of the text documents, in part, the important early works of Yamamoto concerning the treatment of gyroscopic moments, disk skew, free and forced vibration of continuous, and asymmetrical rotor systems. Their treatment of nonlinear vibrations adds the newer areas of research and analysis by Ishida. Included are discussions of chaotic vibration, harmonic resonance, and cracked rotor vibration. The collected works of both authors cover more than a half-century of research into the dynamics and stability of rotating machinery.

The last half of the text discusses many additional topics necessary for a modern and more complete coverage of rotating machinery analysis. Internal damping mechanisms and non-stationary vibrations for passage through critical speeds are discussed in detail. Other related topics include ball bearings, bearing pedestals, universal joints, oil bearings, annular seals, gas labyrinth seals, tip clearance excitation, and liquid filled hollow rotors. Some of these topics are not covered in great detail, but refer to the work of other researchers in this field of study.

The authors present a summary of the finite element method and relate their derivations to the similar work of Nelson. The comparison of their proposed classic solution method using second-order equations to that of Nelson, who used a solution based on coupled first-order equations, is very instructive. Results are presented for the natural frequency of a uniform shaft on simple supports. Also presented are the results for a single disk including gyroscopics, mounted off mid-span on a slender shaft. These results will be of use to researchers developing their own computer analysis capabilities for such calculations.

The authors are to be commended for including a chapter on the transfer matrix solution method. This solution method can and has been made very efficient for extensive analysis of modern turbomachinery. The formulation presented by the authors for the computation of forced response to imbalance can be extended to the computation of dynamic stability. The final chapter briefly covers measurement and signal processing of vibration signals. The coverage is very limited on this topic, but does prompt the reader to be aware of the problems with FFT analysis, such as leakage error.

The text has been carefully written and includes analytical documentation of several interesting nonlinear effects. The authors present the material mainly from the theoretical viewpoint; the text would be of great value for graduate students or other researchers needing to more fully understand dynamic analysis of rotating machinery. The purpose in writing this text, as stated in the Preface, was to add to the documentation of analytical methods for the study of rotordynamics. The authors have satisfied their purpose. *Linear and Nonlinear Rotordynamics: A Modern Treatment with Applications* is a welcome addition to current reference texts now available in the area of rotordynamics.

5R12. Mathematical Aspects of Numerical Solution of Hyperbolic Systems. Monographs and Surveys in Pure and Applied Mathematics, Vol 118. - AG Kulikovskii *(Dept of Mech, Steklov Math Inst, Russian Acad of Sci, Moscow, Russia)*, NV Pogorelov *(Inst for Problems in Mech, Russian Acad of Sci, Moscow, Russia)*, and AY Semenov *(General Phys Inst, Russian Acad of Sci, Moscow, Russia)*. Chapman and Hall/CRC, Boca Raton FL. 2001. 540 pp. ISBN 0-8493-0608-6. $94.95.

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

The conservation laws are usually quasilinear partial differential equations of hyperbolic type, therefore equations of this type play an exceptional role in physics, mechanics etc. But equations of this type have their own special ‘‘stubborn character,’’ therefore various methods were invented for numerical treatment of them. The authors of the book undertake the effort to systemize these methods and to point out similarities and differences between them. Also they show, with examples from mechanics, physics, and engineering, the efficiency of the presented methods.

The book consists of seven chapters. In Chapter 1, the basic notions indispensable for the numeric analysis and the basic properties of hyperbolic systems, such as existence of smooth and discontinuous (shock waves) solutions, are briefly discussed. It is worth to note here that they use the notion of a so-called *generalized solution* to introduce shocks, which is a little bit different from the notion of weak solution used in the western literature. The content of this chapter is strictly limited to what is absolutely necessary for understanding the properties of solutions of hyperbolic systems and the used numeric methods. It is very insufficient from the point of view of a mathematician, for example the name of Glimm is not mentioned even in the references.

Chapter 2 is devoted to a presentation of numerical methods. They are divided into two types: shock-capturing and shock-fitting methods; various specific schemes belonging to each of these groups are discussed. They are presented in an encyclopedic fashion—no formal theorems or their proofs are given; the reader is sent to the suitable references (mainly Russian or Soviet).

In the following four chapters the use, the advantages and disadvantages of these methods are discussed via their applications.

In Chapter 3, applications of these methods to the gas dynamics equations are given. One-dimensional, multidimensional, unsteady, and stationary problems are discussed. Also fixed and moving grids are presented. The chapter ends with some numerical results.

In Chapter 4, the Godunov-type methods designed for computations of many specific problems arising in the shallow water equations are discussed. Exact solutions and the types of discontinuities are given. Finally, numerical results for some one- and two-dimensional problems illustrate the use of the exact and approximate Riemann solvers.

Chapter 5 is devoted to the MHD equations. Since this system of equations consists, roughly speaking, of the gas dynamics equations and the Maxwell equations, the general structure of this overall system is explained first. Next, the types of discontinuities are discussed. How to cope numerically with the enormous variety of problems inherent in magnetohydrodynamics is shown with examples.

Chapter 6 concerns some problems arising in the numeric analysis of solid materials. These include not only the classical elasticity (the Hook law), but also plastic and viscoplastic flows, as well as the dynamics of elastoplastic materials. Much attention, accompanied by examples, is attached to various aspects of the shell theory.

The final part of the book, Chapter 7, is concerned with non-classical hyperbolic systems as opposed to the problems discussed in the preceding part of the book. The variety of non-classical problems is, presumably, unlimited. So, the authors present only some of them, mainly according to their personal interests. These include small-amplitude waves in anisotropic media, electromagnetic waves in ferromagnets, shock waves in composite materials, nonlinear waves in elastic rods, and ionization fronts in a magnetic field. In this chapter, only the mathematical peculiarities of such systems are presented; no numerical schemes are given. The material given in this part of the book covers all non-classical problems, but much could be added, for instance, hyperbolic-elliptic problems. It seems the aim of this chapter was to show the reader that the applications of hyperbolic systems discussed in the previous chapters do not exhaust all possibilities.

The book hardly can be treated as a textbook; it does not answer many *naive* questions a beginner usually has, but it can be used for graduate-level courses. As a matter of fact, this book, *Mathematical Aspects of Numerical Solution of Hyperbolic Systems*, is as a sort of encyclopedia on numerical techniques applied to hyperbolic systems. Being free of, although important, mathematical and physical details, it allows the authors to focus the reader's attention on the core of numerics. The book is worthy of being in the library of everyone interested not only in numerical methods, but also in applied mathematics, mechanics, physics, and engineering since the hyperbolic conservation laws are the basis of these areas of research.

5N13. Computational Aspects of Nonlinear Structural Systems with Large Rigid Body Motion. NATO Science Series, Computer and Systems Sciences, Vol 179. - Edited by JAC Ambrosio and M Kleiber. IOS Press, Amsterdam, Netherlands. 2001. 275 pp. Hardcover. ISBN 1-58603-160-0. $90.00.

Major developments achieved in the fields dealing with computational methods for the analysis of nonlinear structures experiencing large rigid body motion and with flexible multibody systems with nonlinear deformations are finding their way into the commercial general-purpose software in both finite elements and numerical tools for complex industrial applications. Unfortunately, the efforts of scientific communities, such as those dealing with finite elements, multibody dynamics, and numerical analysis, do not have the desired interaction. Consequently, major findings in each of the scientific areas are slow to reach other communities preventing that the scientific progress that can be achieved in areas of common interest to reach its full potential.

This book, which is an outgrowth of a NATO Advanced Research Workshop that brought together leading scientists, aims to fill such a gap by assessing the current state-of-the-art and providing specific results from the different schools of thought with a focus on the trends for future research.

5N14. Impact: The Theory and Physical Behavior of Colliding Solids. - W Goldsmith. Dover Publ, Mineola NY. 2001. 379 pp. Softcover. ISBN 0-486-42004-3. $19.95.

This Dover edition is an unabridged republication of the work originally published in 1960 by Edward Arnold (Publishers) Ltd, London. The Dover edition has been corrected by the insertion of an errata list.

5N15. IUTAM Symposium on Nonlinearity and Stochastic Structural Dynamics. Held in Madras, Chennai, India, January 1999. - Edited by S Narayanan *(Dept of Appl Mech, Indian Inst of Tech, Madras, India)* and RN Iyengar *(Central Build Res Inst, Roorkee, India)*. Kluwer Acad Publ, Dordrecht, Netherlands. 2001. ISBN 0-7923-6733-2.

Nonlinearity and stochastic structural dynamics is of common interest to engineers and applied scientists belonging to many disciplines. Recent research in this area has been concentrated on the response and stability of nonlinear mechanical and structural systems subjected to random excitation. Simultaneously, the focus of research has also been directed towards understanding intrinsic nonlinear phenomena like bifurcation and chaos in deterministic systems. These problems demand a high degree of sophistication in the analytical and numerical approaches. At the same time, they arise from considerations of nonlinear system response to turbulence, earthquake, wind, wave, and guidancy excitations. The topic thus attracts votaries of both analytical rigor and practical applications.

This book gives new developments in the field presenting in a coherent fashion the research findings of leading international groups working in the area of nonlinear random vibration and chaos.

5N16. Monte Carlo Simulation. Proc of Int Conf MCS-2000, Monte Carlo, Monaco, June 2000. - Edited by GI Schueller and PD Spanos. Balkema Publ, Brookfield VT. 2001. 670 pp. ISBN 90-5809-188-0. $158.00.

This volume contains 83 papers on: Random number of generators; weight controlled algorithms and variance reduction techniques; genetic algorithms; algorithms: methods; materials modeling; systems reliability; structural reliability; time variant problems; dynamical systems; earthquake hazards and seismic risk; wind problems; and applications to engineering problems.

Advanced Dynamics. - RB Bhat *(Concordia Univ, Montreal, Canada)* and RV Dukkipati *(Sch of Eng, Fairfield Univ, Fairfield CT 06430-5195)*. Narosa Publ, New Delhi, India. Distributed in USA by CRC Press LLC, Boca Raton FL. 2001. 395 pp. ISBN 0-8493-1018-0. $99.95. (Under review)

Flow-Induced Vibration of Power and Process Plant Components: A Practical Workbook. - MK Au-Yang *(Retired, Lynchburg VA)*. ASME, New York. 2001. 479 pp. ISBN 0-7918-1066-7. $65.00. (Under review)

Transient Aerohydroelasticity of Spherical Bodies. (Foundations of Engineering Mechanics.) - AG Gorshkov and DV Tarlakovsky *(Dept of Appl Mech, Moscow Aviation Inst, Volokolamskoe Shosse 4, Moscow, 125871, Russia)*. Springer-Verlag, Berlin. 2001. 289 pp. ISBN 3-540-42151-3. $99.00. (Under review)

III. AUTOMATIC CONTROL

5R17. Identification and Control of Mechanical Systems. - Jer-Nan Juang *(Struct Dyn Branch, NASA Langley Res Center, Hampton VA 23665)* and Minh Q Phan *(Thayer Sch of Eng, Dartmouth Col, Hanover NH)*. Cambridge UP, Cambridge, UK. 2001. 334 pp. ISBN 0-521-78355-0. $80.00.

Reviewed by L Dewell (Adv Tech Center, Lockheed Martin Space Syst, 1111 Lockheed Martin Way, Sunnyvale CA 94089).

This textbook presents the concepts and results of modern, multivariable control theory, with a particular focus on its application to mechanical systems. The book is tailored to an audience which is not familiar with multivariable systems analysis, including linear algebra, linear system theory, etc. It is suitable as a textbook for an advanced undergraduate course in linear systems theory and modern control. In the opinion of this reviewer, it is ideally suited as a textbook for practicing engineers from fields other than dynamics and control, who, through self-study or in a group, wish to gain an understanding of the underpinnings of modern control systems. The authors suggest that the book is also appropriate for graduate study, but it seems to lack the technical depth for study at the graduate level.

The book begins with three chapters dealing with the theory of ordinary differential equations, linear algebra, and the derivation of equations of motion. The next two chapters extend the treatment of dynamic systems to the field of structural dynamics through a treatment of the finite element method and the vibration of beams. Subsequent chapters variously present the concepts of modern control. Chapter 6 discusses stability augmentation of structural dynamic systems through position, rate, or acceleration feedback; Chapters 8 and 9 discusses the general problem of regulation and tracking using full-state and output feedback. Finally, the book concludes with two chapters dealing with advanced topics of system identification and predictive control.

Several chapters of this book are excellent, self-contained treatments of subjects which have previously been dispersed in various textbooks on control and linear systems theory. For example, Chapter 2 is one of the best summaries of linear algebra for control systems engineers that this reviewer has seen in a textbook. Chapters 5 and 6 are an outstanding introduction to the problems of flexible structures and their control. Finally, the treatment of system identification in Chapter 10 brings out the essential features of recent results in the field in a manner which is manageable to the uninitiated.

This book is particularly strong in its presentation of flexible structure control. The authors do an excellent job of illustrating stability augmentation of a flexible-body system using so-called *virtual passive controllers*. In particular, the authors show that the damping of a structural dynamic system cannot be augmented by position sensors alone, if the controller structure is limited to static controllers. However, with dynamic controllers obeying a second-order form, damping can be augmented to any desired degree using only position feedback. In addition, the authors make a conscious effort to present many of the results while staying within the second-order form which is so familiar to structural dynamicists, in addition to showing the results in the first-order, state-space form. Although this choice carries a certain burden of additional analysis and discussion, it serves the structural dynamics community well.

The authors' choice of arrangement of the chapters was sometimes difficult to understand. It seemed to this reviewer that Chapters 4 and 5 were written independently, without mutual comparison for overlapping material. In fact, it occurred to this reviewer that the finite element method of Chapter 4 should have appeared as a final section to Chapter 5. Chapter 7 seemed out of place in the second half of the book, being a basic treatment of state-space systems. It would have been more appropriate if this material appeared near the beginning of the text.

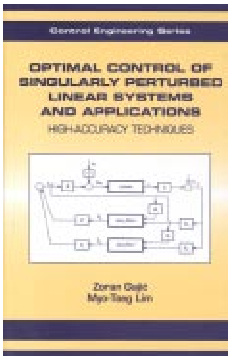
Despite some reservations about organization or presentation, which are inevitably subjective to some extent, this reviewer found the book enjoyable and easy to read. The treatment of pole-placement using the singular-value decomposition was interesting and well worth the study. It was particularly pleasant to examine the examples, as the authors carefully chose examples which were just complex enough to illustrate the point at hand, while not being so involved as to muddy the water with other concepts or considerations. In summary, *Identification and Control of Mechanical Systems* seems to be an excellent vehicle for the study of modern control by advanced undergraduate students, and particularly for practicing engineers in structural dynamics who wish to bridge the technical gap between dynamics and control.

5R18. Optimal Control of Singularly Perturbed Linear Systems and Applications: High-Accuracy Techniques. - Z Gajic *(Elec and Comput Eng Dept, Rutgers Univ, Piscataway NJ)* and Myo-Taeg Lim *(Korea Univ, Seoul, Korea)*. Marcel Dekker, New York. 2001. 309 pp. ISBN 0-8247-8976-8. $150.00.

Reviewed by J Bentsman (Dept of Mech and Indust Eng, MC-244, Univ of Illinois, 1206 W Green St, 332e meb, mc 244, Urbana IL 61801).

This book is intended for researchers in control theory, graduate students, and control engineers. The book presents computational methods that permit high accuracy controller design of singularly perturbed systems. A number of applications are considered where the use of the methods is demonstrated.

The main theme of the book is the exact or highly accurate approximate decomposition of the numerically ill-conditioned optimal control and filtering problems for the original singularly perturbed system into two well-conditioned sub-problems separately governing fast and regular motion, with the latter being referred to as slow motion. The decomposition is accomplished via coordinate transformation that can be computed recursively. The decomposition is applied either to the original singularly perturbed system yielding two subsystems that govern pure-slow and pure-fast system motion or solution of the control problem for the original system, decomposing this solution into two easily computable pure-slow and pure-fast sub-solutions.



The book is organized into nine chapters. It starts with the detailed introduction, Chapter 1, that reviews the literature on the subject and presents the main technical milestones and approaches: Chang transformation that exactly decouples a linear singularly perturbed system into independent slow and fast subsystems, Hamiltonian approach that permits block-diagonalization of the Hamiltonian matrices for optimal control and filtering problems into pure-slow and pure-fast Hamiltonian matrices, and recursive numerical procedures for obtaining the necessary decompositions.

Chapters 2 and 3 consider continuous-time and discrete-time linear quadratic optimal control and filtering problems for singularly perturbed systems. They present the method for the exact decomposition of the algebraic Riccati equation corresponding to the original system into two reduced order algebraic Riccati equations corresponding to slow and fast time scales. Chapter 4 presents the methods for the exact decomposition of the Riccati equation for the singularly perturbed system with two fast motions with different motion rates into equation for slow subsystem and two equations for fast subsystems. Chapter 5 presents similar decompositions for the H-infinity control and filtering problems. Chapter 6 presents decompositions for high gain and related cheap control problems as well as the dual small measurement noise filtering problem. Chapter 7 presents Riccati equation decompositions using the numerically attractive eigenvector approach. Chapter 8 considers decomposition of nonstandard singularly perturbed systems, addresses finite horizon closed-loop optimization, reviews slow-fast manifold theory, and compares it with the Hamiltonian approach. Chapter 9 briefly gives concluding remarks and indicates open research problems in this area.

Optimal Control of Singularly Perturbed Linear Systems and Applications: High-Accuracy Techniques is well focused, considers application examples, and provides high quality computational procedures. It has detailed subject index. This reviewer would highly recommend this book to researchers in singular perturbation. The book is also a necessary addition to any good technical library.

5R19. Optimal Control: An Introduction. - A Locatelli *(Dept di Elettronica e Informazione, Politecnico di Milano, Piazza L da Vinci 32, Milano, 20133, Italy).* Birkhauser Verlag AG, Basel, Switzerland. 2001. 294 pp. ISBN 3-7643-6408-4.

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

Optimization is the collective process of finding the set of conditions required to achieve the best result from a given situation. Frequently its teaching is connected to an extent with control science as the field which has attained a high level of competence in advanced design of practical devices, complex industrial systems, robotics, and flying objects. Extensive research in dynamic optimization, especially with reference to robust control problems, has caused it to be regarded as valuable source of numerous useful, powerful, and flexible tools for both engineers and scientists. The link of optimal control with variational calculus, an older although still vital discipline, influences the opinion that many results of variational techniques are particularly suited when approaching nonlinear solutions of complex control problems. Therefore, even though first breaking discoveries in the optimal control were published more than 40 years ago, novel treatments of the fundamentals of classical optimal control theory are still important and of immediate interest. This book is a good example of accomplishing that task. The book is at a high scientific level and represents an integrated view of the discipline. Still its choice of topics, the relative weight given to them, and the nature of illustrative examples reflect the author's commitment to effective teaching. The book is designed for both undergraduate and graduate students who have already been exposed to basic linear system and control theory and have the calculus background usually found in undergraduate curricula in engineering. Yet, graduates and teachers will also benefit from using the book.

Almost any problem in the analysis, operation, and design of practical processes and industrial operations, and many associated problems, such as production planing, can be broken down in its final stage to the problem of determining the largest or smallest value of a function or a functional. Optimization of an arbitrary system requires knowledge of a model of a controlled system, the evaluation criterion called performance index, and constraints (not yet accounted for by the model). The constraints can be of different sort and may be given in diverse forms. When dynamical problems are in question, a typical optimization model consists of an integral functional, a set of constraining differential equations, and some local constraints imposed on control and/or state variables. That functional should be maximized or minimized. The task of optimization is then to find the best dynamics in terms of the best control functions and corresponding optimal trajectory.

The book is composed of two parts: the first is devoted to global methods (sufficient optimality conditions), whereas the second deals with variational methods of the first order (necessary conditions) or second order (locally-sufficient conditions). The first part develops the basis of the Hamilton-Jacobi theory that provides sufficient conditions for global optimality along with its most essential accomplishments, namely the solution of the Linear Quadratic and Linear Quadratic Gaussian problems. Some attention is given to the Ricatti equations which play an essential role in these problems. The second part of the book begins with the presentation of the Pontryagin's Maximum Principle, which represents the first-order variational approach and provides both powerful and elegant necessary conditions encompassing a wide class of complex problems. The second-order variational approach is displayed next and is shown to be capable of ensuring, under suitable conditions, the local optimality of solutions derived from the Maximum Principle.

The Introduction to the book concisely describes the standard optimal control problem along with its basic features. Numerous examples displaying typical and basic formulations are given in Chapter1 (Introduction). Typical problems considered are rendezvous problem, positioning (or transfer) problem and attitude control problem with a minimum consumption of fuel. The presentation in terms of definitions and analyses involved is both rigorous and lucid. Chapter 2, with a variety of examples, does a particularly elegant job of laying out results of a global nature in the form of Hamilton-Jacobi theory for functionals of Bolza type. Chapter 3 discusses the linear-quadratic problem for Bolza functionals in case of finite and infinite control horizons. Its special case, discussed in detail, is the optimal regulator problem in which coefficients are constant. Again, many suitable and illuminating examples are given. A minor flaw here is that most of them come from the realm of electric circuits theory and lumped system mechanics, but they are sufficiently simple and nice to attract readers representing different fields. Stability properties of the optimal regulator problem along with robustness properties are also analyzed in detail. An inverse optimal problem is also formulated and discussed. It consists of finding, for a given system and control law, a performance index with respect to which such a control policy is optimal. The restriction to linear dynamics with the quadratic performance index is mandatory, in this case, because the nonlinear problem is extremely difficult to solve and requires satisfaction of complex (Helmholtz) conditions known from variational calculus. Chapter 4 considers Linear Quadratic Gaussian problems. The dynamical equations of this chapter represent a non-zero mean, Gausian, stationary, multidimensional process which is assumed to be a white-noise. The initial state is an n-dimensional Gaussian random variable. The uncertainty of the system is specified, and problems are considered with the optimal estimate of the system state and the optimal stochastic control of it. In particular, Kalman filter is treated and associated examples are displayed. Chapter 5 deals with Ricatti equations in differential and algebraic forms which play a particular role in these problems.

The Pontryagin's Maximum Principle in Chapter 6 begins the presentation in the second part of the book. Hamiltonian and auxiliary system of adjoint equations are defined along with simple constraints. First control problems require that no complex constraints are present on the state and control variables. Examples are given that display necessary optimality conditions for wide class of complex problems. Complex constraints are treated next, imposed on state and control. Also, integral constraints and global instantaneous (equality and inequality) constraints are considered. The latter are adjoint to the Hamiltonian, and all previous results are exploited with reference to the modified Hamiltonian function. Role of isolated equality constraints is investigated. Singular optimal control problems are also considered and exemplified along with time optimal control problems. Quite a comprehensive review of the second variation method is given in Chapter 7. The issues such as: local sufficient conditions and neighboring optimal control are considered. To warrant the self-contained structure of the book, suitable mathematical Appendices are included.

One of the key concepts of the contemporary optimal control and its distinguishing feature is that it can take account of dynamic and pathwise constraints. The book contributes well to the understanding of the theory of Pontryagin's maximum principle and the relationship between the optimal performance function and the Hamilton-Jacobi equation. The analysis is largely self-contained and provides a unified perspective on dynamic optimization problems which are beyond the realm of trivial analytical and computational techniques. Moreover, this analysis includes many of the unifying properties and simplifications discovered in recent research. Its didactic line complies with recent developments in optimal control, aimed at extending the range of application of available necessary optimality conditions and stressing similarities rather than differences with the variational calculus. In fact, the book shows that it is possible to derive, in the optimal control context, optimality conditions of remarkable generality by using the mathematical apparatus for solutions to the Hamilton-Jacobi equation. One highlight of these approaches is the clarification of the relationship between the optimal performance and the Hamilton-Jacobi equation. Another important achievement of the book is to make the contemporary results of the optimal control theory accessible to a wide audience without requiring extensive prior knowledge of optimization theory.

The number of examples and their didactic value are impressive. A flaw is the limitation in scope resulting from the omission or reduction of certain topics. Notably among these are 1) the role of Kuhn-Tucker theorem, convex sets, and penalty approaches for global optimality; 2) the dynamic programming, Bellman's functional equations, and enunciation of relations between the optimal trajectories and cost surfaces in this context; 3) the numerical integration schemes for ordinary differential equations (ODEs) constructed in such a way that a qualitative property of the solution of the ODE is exactly preserved, eg, Hamilton's-structure-preserving integration schemes (symplectic integrators and invariants). The latter topic conforms with the present tendencies in numerical physics.

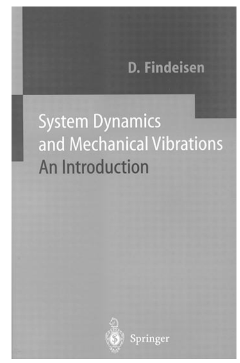
The book may be used by a relatively broad audience comprising postgraduates, researchers, and professionals in engineering, process control, system science, and applied mathematics. It is written clearly and represents a readable, self-contained text with suitable basic references and a good subject index. It also has simple and clear, good quality figures. That text represents a step forward in teaching optimal control by putting the collection of nontrivial problems into a cohesive framework displayed at the level of detail that a student or teacher willing to put some effort could follow.

In summary: *Optimal Control: An Introduction* represents a valuable and rigorous approach, of remarkable didactic value. The book is well written and well edited in terms of organization, technical writing, and the use of illustrations. It deserves space on the bookshelf of any teacher and student interested in optimal control and related fields.

5R20. Systems Dynamics and Mechanical Vibrations: An Introduction. - D Findeisen *(Dept 11 Mech Eng and Prod Tech, Inst of Machine Des, Tech Univ, Strasse des 17 Juni 135, Berlin, 10623, Germany)*. Springer-Verlag, Berlin. 2000. 383 pp. ISBN 3-540-67144-7. $99.00.

Reviewed by K Popp (Inst of Mech, Univ of Hannover, Appelstr 11, Hannover, D-30167, Germany).

The preface says this book is intended to be a professional reference book, but it should also prove suitable as a textbook for courses ranging from the junior level to the senior level. The author is head of the Institute of Machine Design at the Technical University of Berlin. He describes the aim of the book as to give practicing designers, engineers, and students of mechanical engineering a thorough understanding of the fundamentals of system dynamics. The author believes that the three subjects—rigid-body dynamics, vibrations, and control—belong together, and thus he tries to give an integrated basis of system dynamics and vibrations.



The book comprises five chapters and three appendices. It has good quality figures, a well structured index, and 125 references for further reading. Chapter 1 introduces the subject of system modeling and presents a general classification of physical quantities (per- and transvariables or through and across variables), following the famous book by MacFarlane on *Engineering Systems Analysis* (1964). The next two chapters are due to the system representation by diagrams and equations, respectively. In Chapter 2, significant types of systematic diagrams which apply to both electrical circuits and dynamics of control are presented to demonstrate their use for creating mechanical model systems (mechanical circuits). Chapter 3 provides mathematical relations between the system variables of interacting mechanical subsystems. Emphasis is laid on phasor response analysis, Fourier series analysis as well as Fourier- and Laplace-transform techniques. The chapter is concluded by a comparison of both integral transforms. In Chapter 4, frequency-response analysis comes into focus. Here, the concepts of mobility and dynamic compliance are introduced and worked out in detail. Chapter 5 treats the flow of power and energy in systems. The power transmission through linear two ports as well as mechanical networks is investigated in detail. The three appendices that conclude the book show graphs of time-history curves, usual frequency response plots and frequency response plots of power.

System Dynamics and Mechanical Vibrations is restricted to linear systems. In this reviewer's opinion, the most beneficial aspect is the interdisciplinary approach, common in control engineering. It starts with the classification of variables that can help to solve interdisciplinary mechatronic problems. However, there are also many drawbacks. The reader will miss modern analysis and control techniques using the state space approach as well as progressive matrix methods, the use of today's computer tools for solving problems, consideration of large multi-degree-of-freedom systems or systems with distributed parameters, applications of modal-transform techniques, etc. Maybe the most severe drawback is that the book does not contain any examples, exercises, or problem with solutions. Thus, in summary, this reviewer cannot recommend this book as a textbook for students. But *Systems Dynamics and Mechanical Vibrations: An Introduction* can serve as a reference for interested readers, so it may find a place in libraries.

5N21. Nanometer Scale Science and Technology. Volume 144 International School of Physics ''Enrico Fermi.'' - Edited by M Allegrini, N Garcia, and O Marti. IOS Press, Amsterdam, Netherlands. 2001. 470 pp. Hardcover. ISBN 1-58603-165-1. $145.00.

Nanoscience and nanotechnology are at the interface between physics, chemistry, engineering, and most importantly, biology. Micro-electrical mechanical systems are approaching the dimensions of biological cells, opening up the possibility of connecting machines to individual cells. This book is based on local probes (STM, AFM, SNOM) and related supreme technological achievements. These topics are extensively covered in the book, mainly devoted to instrumentation aspects. From a more fundamental point of view, it also covers advanced subjects such as clusters, nanocontacts, photonic band gap materials, atom manipulation by light, atom optics with Bose-Einstein condensates, and quantum computing.

Liapunov Functions and Stability in Control Theory. Lecture Notes in Control and Information Sciences 267. - A Bacciotti *(Dipt di Matematica, Politecnico di Torino, Italy)* and L Rosier *(Lab d' Analyze Numerique et EDP, Univ Paris 11, France)*. Springer-Verlag, New York. 2001. 208 pp. Softcover. ISBN 1-85233-419-3. $69.80. (Under review)

Non-linear Control for Underactuated Mechanical Systems. - I Fantoni and R Lozano *(UMR CNRS 6599, Univ de Technologie de Compiegne, BP 20529, Compiegne, 60205, France)*. Springer-Verlag London Ltd, Surrey, UK. 2002. 295 pp. ISBN 1-85233-423-1. $109.00. (Under review)

IV. MECHANICS OF SOLIDS

5R22. Heterogeneous Media: Micromechanics Modeling Methods and Simulations. (Modeling and Simulation in Science, Engineering and Technology Series.) - Edited by K Markov *(Fac of Math and Informatics, Univ of Sofia, St Klimentohridski, Sofia, BG-1164, Bulgaria)* and L Preziosi *(Dept di Matematica, Politecnico di Torino, Torino, I-10129, Italy)*. Birkhauser Boston, Cambridge MA. 2000. 477 pp. ISBN 0-8176-4083-5. $79.95.

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

The editors have put together five articles by different authors and organized them into the present book, all dealing with some aspect of the title subject. The editors have also authored or co-authored some of the chapter/articles, which average close to 100 pages each. The titles of the five chapters are as follows: 1) Elementary Micromechanics of Heterogeneous Media, by K Markov, 2) Diffusion-Absorption and Flow Processes in Disordered Porous Media, by S Torquato, 3) Self-Consistent Methods in the Problem of Wave Propagation through Heterogeneous Media, by S Kanaun, 4) Deformable Porous Media and Composite Manufacturing, by A Farina and L Preziosi, and finally, 5) Micromechanics of Poroelastic Rocks, by R Zimmerman.

These chapters all attempt to present models and mathematical tools to predict the overall macro-reaction of a medium structure taking into account the medium's micro-structure. These models are tested or realistic examples, explicit results are extracted in analytic or numerical form, and then a comparison with the experimental findings is performed. The degree of coincidence between prediction and experimental observation is a test of the model accuracy. The authors and editors have attempted to unify all the *languages* and ways of thinking about these problems present in many disciplines such as solid and fluid mechanics, solid state physics, biomechanics, etc. It is hard to summarize these chapters in the brief paragraphs of this review, but our attempt follows.

Markov's first chapter reviews the introductory ideas related to *homogenization*. It replaces heterogeneous media by homogeneous ones which macroscopically behave in the same way by having some gross *effective properties*. These are related in a complex way to the medium's internal structure. There is a large historical background here over the last 200 years and many references (180) are cited, although ten times that amount could have also been easily mentioned. The examples and references cover all the above-mentioned fields and concern conductivity, elasticity, polycrystals, etc. The next four chapters are more specialized.

Torquato's second chapter deals with rigorous methods to estimate the effective properties associated with two types of processes present in random porous media: diffusion-absorption and flow-phenomena. The first one examines the *trapping constant* or mean survival time, and also diffusion-relaxation times. The second process deals with fluid permeability and viscous relaxation times. Several topics are presented and some of the most interesting include rigorous bounds on the effective properties in terms of correlation functions and cross-property relations that link diffusion to flow properties. It cites about 60 representative references.

Kanaun's third chapter considers the evaluation of mean wave fields and the effective *dynamic* properties of random composites with microstructure. It is the only chapter dealing with dynamic (ie, frequency-dependent) properties. The main emphasis goes to two of the main *self-consistent* schemes: the effective field and the effective medium approaches. An example includes monochromatic electromagnetic (EM) waves propagating through particulate composites, and there is some discussion on the sources of possible inaccuracies of these methods and of ways to overcome them. About 40 references are cited for the case selected. This is the area of greatest interest to this reviewer. There is a very large body of knowledge on this topic in the Acoustics literature that is unfortunately not mentioned.

The fourth chapter by Farina and Preziosi reviews appropriate models to mathematically describe porous media. This leads to applications in composite materials manufacturing, a key issue in the real production technologies of composites. Many industries demand special advanced materials satisfying strict requirements and lower cost, and these requirements involve a mixture of various properties that should act synergistically to satisfy the needs of the application. About 150 references are cited and discussed to some extent. The presentation is quite theoretical, and some of the sources cited range from early works of Darcy, Eringen, and Truesdel, to more recent ones by the authors, still in press.

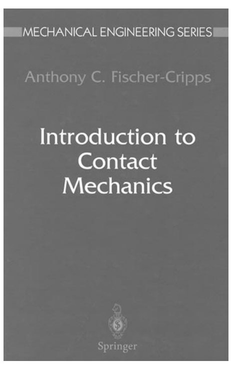
The final fifth chapter by Zimmerman reviews the poroelactisity of rock-like media. The emphasis here goes to the micro-scale deformation of the pore space. A non-linear (and later a linearized) theory of the deformation of porous media under hydro-static loading is presented. The seminal work of M Biot is discussed at length and also some of its later extensions, including works of T Plona and of the author of the present chapter himself. There are about 100 references cited.

This is not a textbook. It is a reference book for the practitioner. However, the editors express the wish that perhaps some of these chapters could be used in graduate courses for PhD students in applied and industrial mathematics. There are few figures, but many references. *Heterogeneous Media: Micromechanics Modeling Methods and Simulations* is recommended for graduate students and institutional libraries, as well as for the design practitioner in the field.

5R23. Introduction to Contact Mechanics. Mechanical Engineering Series. - AC Fischer-Cripps *(CSIRO, Bradfield Rd, W Linfield, Lindfield NSW, 2070, Australia).* Springer-Verlag, New York. 2000. 243 pp. ISBN 0-387-98914-5. $79.95.

Reviewed by KL Johnson (Dept of Eng, Univ of Cambridge, Trumpington St, Cambridge, CB2 1PZ, UK).

Contact Mechanics—the quantitative study of the stresses and deformation at the contact of solid bodies—is a wide and growing area of the Applied Mechanics of Solids, so that it is perhaps surprising that there are so few textbooks in the field. The subject can be thought to have begun with Hertz's classic paper: ''On the contact of elastic solids'' in 1882. Hertz's theory was extended in the first half of the 20th century by applied mathematicians mainly in Germany and Russia, driven by technological developments in the railway, ball bearing, and toothed gear industries. It was recognized as an important constituent when, in 1966, studies of friction, lubrication, and wear were gathered together under the title: Tribology.



The first book in the field was: *Contact Problems in the Theory of Elasticity*, by LA Galin, 1953 (translated from the Russian by H Moss and published by North Carolina State College, 1961). This was followed by *Surface Mechanics* by FF Ling (Wiley, 1971), which is how it stood until this reviewer's own broad survey of the field, *Contact Mechanics* (Cambridge University Press) in 1985. Since then there have been several excellent books concentrating on separate aspects of the subject: *Three-Dimensional Elastic Bodies in Rolling Contact* by JJ Kalker (Kluwer, 1990); *Mechanics of Elastic Contacts* by Hills, Nowell, and Sackfield (Butterworth-Heinemann, 1993); *Contact Mechanics using Boundary Elements* by KW Man (Comp Mech Pub, 1994), and one by Galin's students, IG Goryacheva: *Contact Mechanics in Tribology* (Kluwer, 1998).

The present book, *An Introduction to Contact Mechanics* by AC Fischer-Cripps, does not pretend to be comprehensive. It is intended to provide a working tool for the experimental materials scientist, of whom the author is one. The mathematical sophistication of elastic contact theory is reduced to a minimum. The scope of the book reflects the author's interest in indentation testing in general and of brittle materials in particular. The current wide interest in indentation testing, especially on the micro and nano scales, makes the book particularly timely.

The book opens with a very brief review of the equations of continuum mechanics, followed by a chapter on elastic fracture mechanics. The elastic stress fields under purely normal loads, including the Hertz contact theory are then presented, followed by a chapter on Hertzian fracture of brittle materials. The final third of the book is concerned with hardness and the indentation of elastic-plastic solids, including a chapter on ''Indentation test methods.''

The author succeeds in his aim to produce a readable reference text for experimentalists who might be daunted by much of the literature in the field. Perhaps the most serious omission is the use of indentation testing to extract the material properties of thin surface coatings. An Appendix considers ''Sub-micron indentation analysis,'' but does not mention adhesive effects which become important with small contacts.

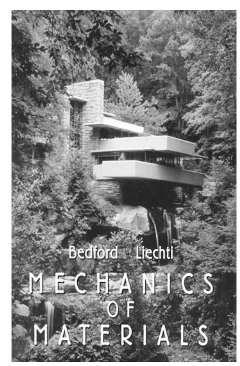
5R24. Mechanics of Materials. - A Bedford and K Liechti *(Dept of Aerospace Eng and Eng Mech, Univ of Texas, Austin TX).* Prentice Hall, Upper Saddle River NJ. 2000. 627 pp. CD-ROM included. ISBN 0-201-89552-8. $103.00.

Reviewed by M Epstein (Dept of Mech Eng, Univ of Calgary, 2500 University Dr NW, Calgary AB, T2N 1N4, Canada).

In a market already flooded with textbooks on Mechanics of Materials, the appearance of yet another one is greeted with a mixture of skepticism and hope. The preface to this book starts by feeding the latter when it declares that the ''long-held dream of the merger of continuum solid mechanics and material science into a unified field'' is near at hand. Whether or not this is true, or even desirable, this book does little to contribute in pointing the prospective student in that direction. After a statement containing an almost unforgivable spelling error (''the principle emphasis''), the preface gives us a description of the contents of the book. It is practically identical to that of any of the textbooks already available at the same level. Perhaps the only difference is the introduction of the discussion of general states of stress and strain after the treatment of torsion and before the treatment of bending. As usual, however, stress-strain relations are included as a part of the chapter on strain, rather than as a separate chapter on constitutive behavior, thus doing little to advance the long-held dream just mentioned.

Having said all that, the book is professionally produced, with excellent figures and interesting examples. An accompanying CD offers interesting interactive opportunities for practice beyond the problems appearing in the book itself. This feature will certainly be very attractive to students and instructors alike.

The book is organized in 12 chapters and 7 appendices. Chapter 1 consists mainly of a review of Statics. The vector equilibrium equations are stated, but there seems to be no review of the concept of the moment of a force as a vector product. All of the examples discussed are planar, but at the end of the chapter a couple of examples are spatial. It is not clear, therefore, what the student is expected to do. Chapter 2, entitled ''Measures of stress and strain,'' is a good elementary introduction to particular cases where these can be calculated by simple means. In the next chapter, on axially loaded bars, the standard method of introducing Young's modulus and Poisson's ratio is followed. There is a danger here that the student might elevate these concepts to universal truths for all materials, but this is preempted by a good discussion at the end of the chapter on general features of material behavior, particularly under a uniaxial test. Elementary statically indeterminate situations are presented, and a discussion is attempted of the basic two methods (flexibility and stiffness). Unfortunately, this discussion is not very illuminating, and the conceptual difference between the formulations is dismissed in the context of the problems to be treated. One wonders what a student is supposed to do or think with such a piece of information.



Chapter 4 is devoted to torsion of shafts, including some plasticity and simply connected thin-walled tubes. As already mentioned, the next two chapters are devoted to a discussion of the concepts of general states of stress and strain, including Mohr's circle for both. A welcome treatment of the tetrahedron argument and its consequences is one of the nice features of this part of the book. Spherical and cylindrical pressure vessels are used to produce non-trivial examples. Chapter 7 presents the concepts of internal forces in planar beams, including the differential relations between bending moment and shear force.

Chapter 8, at 70 pages the longest of the book, deals with in beams, including the shear formula, composite beams, and elastoplastic response. Chapter 9, on small deflections of planar elastic beams, is adequate, but omits the method of singularity functions. The book ends with three chapters on special topics. Chapter 10 is an introduction to Euler buckling, Chapter 11 deals with energy methods (including Castigliano's second theorem), and Chapter 12 discusses some criteria of failure.

Overall, although not attempting a new methodology, this is a good book that can be used as a textbook for a first course in Mechanics of Materials.

5R25. Mechanics of Non-Homogeneous and Anisotropic Foundations. Foundations of Engineering Mechanics Series. - GB Muravskii *(Geotech Dept, Technion, Haifa, 32000, Israel*). Springer-Verlag, Berlin. 2001. 364 pp. ISBN 3-540-41631-5. $139.00.

Reviewed by JA Cheney (Dept of Civil and Env Eng, UC, Davis CA 95616).

This book contains the results of investigations in the area of statics and dynamics of heterogeneous and anisotropic foundations carried out by the author in the last five years while working in the Faculty of Civil Engineering at the Technion–Israel Institute of Technology. It is a reference book directed toward engineers and scientists in the areas of soil mechanics, soil-structure interaction, seismology, and geophysics. As an introduction to the subject, a list of 134 references is given which is used to discuss previous work in the literature. The purpose of the book is to present a series of solutions (most previously unpublished) for the case of transverse isotropy, and where the characteristics of the half-space vary only with respect to depth.

Special emphasis is made on the studies of steady-state harmonic vibrations of half-spaces under loads at the surface of the half-space or at depth. In addition, a study of harmonic vibrations of a circular stiff disk in contact with the surface of the half-space is presented. Given solutions of problems of harmonic vibration, it is possible to construct solutions for arbitrary time dependent loads.

The book is divided into five chapters. Chapter 1 deals with the problem of vibrations in the transversely isotropic half-space subjected to specific loads. Attention is given to the case of concentrated vertical and horizontal forces, and thus the solutions are available for any arbitrary distribution of loads.

In the following three chapters, problems dealing with the homogeneous transversely isotropic half-space (Ch 2), isotropic linearly heterogeneous half-space (Ch 3), and a transversely isotropic half-space with shear modulus varying exponentially with depth (Ch 4) are considered. In the latter case, two options are considered: first with an infinite increase in shear modulus with depth and, second, one with a finite limit for the shear modulus.

In Chapter 5, numerical-analytical methods of constructing solutions for static and dynamic problems in a heterogeneous half-space are presented. The well-known technique of replacement of a half-space with a set of homogeneous layers is referred to as a numerical method. This technique is coupled with exact solutions of the corresponding differential equations for the layers. Two approaches are employed to construct solutions for the layers: a piecewise constant approximation of the coefficients of the equations and, second, the Runge-Kutta method.

The book presents, graphically, a large number of results of computations which give a clear picture of the behavior of the mechanical systems considered. These results can serve in estimating the accuracy of other simplified methods, such as combining the division of the half-space into thin layers with setting a form of displacement distribution within the layers.

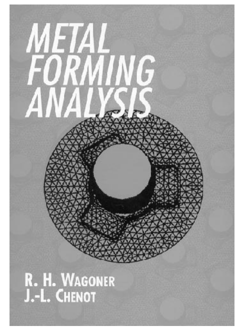
In addition to the extensive reference list, an ample subject index is included. This reviewer believes this book, *Mechanics of Non-Homogeneous and Anisotropic Foundations*, to be a valuable addition to the scientific literature on the subject, and at least should be placed in libraries.

5R26. Metal Forming Analysis. - RH Wagoner *(Dept of Mat Sci and Eng, Ohio State Univ, Columbus OH)* and J-L Chenot *(Mat Forming Center, Ecole des Mines, Paris, France)*. Cambridge UP, New York. 2001. 376 pp. ISBN 0-521-64267-1. $95.00.

Reviewed by WA Knight (Dept Indust and Manuf Eng, Univ of Rhode Island, Gilbreth Hall, Kingston RI 02881).

This work is a comprehensive presentation of the underlying principles and applications of the finite element method to the numerical simulation of both sheet and bulk metal forming processes. In this sense, the title is somewhat misleading as it implies a discussion of metal forming analysis in general, whereas very little is included on the more traditional approaches to metal forming analysis. However, the text is aimed at advanced graduate students and experienced practitioners in industry and elsewhere, who should be already familiar with the physical principles and equations for a basic understanding of metal deformation.

The material in the book is clearly presented, with numerous figures and illustrations that are of high quality. A comprehensive index is included at the end of the text. The first seven chapters are essentially introductory and cover the underlying principles and formulations of the finite element method applied to plasticity analysis. The authors follow a logical step-by-step approach to introducing these principles. Chapter 1 covers basic mathematical principles and a brief review of the mechanical principles of plasticity. In Chapter 2, the finite element method is introduced, and in Chapter 3, the specific extension to large deformation analysis is presented. Chapters 4 and 5 extend the discussion to typical finite element types and classification of finite element formulations. Chapter 6 is devoted to problems of boundary conditions in finite element analysis, including friction and contact between the deforming material and the tools or dies used. The introductory part of the book concludes with discussion of basic thermomechanical principles necessary for the analysis of temperature effects in metal deformation.



The remaining five chapters cover the application of finite element analysis to various types of metal forming. The results of case studies are used throughout to effectively illustrate the approach and the extensive data that can be generated from finite element simulations of the various forming processes. Chapter 8 covers sheet metal formability tests and their simulation. The next two chapters deal with bulk forming processes, with Chapter 9 devoted to steady state processes such as rolling, extrusion, and drawing, while Chapter 10 covers sheet metal forming applications. The final chapter of the book discusses some recent research topics including problems of meshing and remeshing, error estimation, and applications in the numerical modeling of orthogonal machining.

In general, the authors achieve their basic aim of providing a state-of-the-art presentation of the numerical methods for simulating forming operations for advanced graduate students and others utilizing these methods in industry and elsewhere. *Metal Forming Analysis* is an excellent textbook for advanced metal forming analysis courses. Most chapters include a problems section at the end. These problems are conveniently divided into proficiency, depth, and numerical problems. Computer packages based on the principles described in the book have become quite widely used in industry and research laboratories for the simulation and design of forming operations. This book is an excellent reference text for personnel using such packages, who need in depth information on the principles behind these programs. The results of numerical simulations have become accepted as accurate predictions of deformation, temperature, and so on. Perhaps the main thing missing in the text is appropriate experimental results to confirm the accuracy of the numerical predictions or to illustrate any inadequacies of simulations. This is particularly the case for the applications to bulk forming processes described.

5R27. Rolling Contacts. Tribology in Practice Series. - TA Stolarski *(Mech Eng Dept, Brunel Univ, UK)* and S Tobe *(Ashikaga Inst of Tech, Japan)*. Professional Eng Publ, Suffolk, UK. 2000. 445 pp. ISBN 1-86058-296-6. $188.00.

Reviewed by J Kalousek (Center for Surface Transportation Tech, Natl Res Council Canada, 3250 E Mall, Vancouver, BC, V6T 1W5, Canada).

This is a reference book aimed at engineers who work in the fields of rolling contacts, roller bearings, gears, cams, wheel/rail contacts in railways, etc.

Following the introduction, the book summarizes the classical theories of the mechanics of elasticity, the thermal effects of surface roughness, rolling contacts separated by a film, and rolling fatigue. These theories provide analysis tools for different contact problems. The book discusses a number of cases which are commonly seen in engineering, such as: friction in rolling contact, roller bearings (fully lubricated rolling contact), wheel/rail contact (non-lubricated rolling contact), gears and cams (fully or partially lubricated rolling contact), non-metallic rolling contact, surface treatment for rolling contact, and rolling contact during metal forming.

An interesting feature of this book is that it combines all subjects related with rolling contact together into one book. On some topics, such as lubricated rolling contact (bearings, gears and cams), the book provides explanations that range from detailed to exhaustive. However, the information provided on topics such as slip stick in rolling-sliding contact and contact between wheel/rail comes short of covering the current state of the art.

The book contains a wealth of good references, the figures are of very good quality, and the subject indexes are detailed and to the point. But some statements can be found that are either unclear or wrong. For example, Fig. 3.9 on page 70 properly displays the concept of slip-stick. Equation 3.31 on page 71 tells us that $F=F_1$ when $\kappa\Delta\nu/\nu=1$. However, the value of F/F_1 on the thick curve in Fig. 3.9(b) is not equal to 1 at $\kappa\Delta\nu/\nu=1$. Also the μ_R in Fig. 3.9(b) is not defined in the book. The last paragraph on page 71 mentions a dashed line in Fig. 3.9(b), but there is no dashed line in the figure.

In general, *Rolling Contacts* is of good value to large readership ranging from practical engineers to researchers interested in novel ideas. The book is strongly recommended to each professional in the field. It will also become a well sought after reference on the shelf of scientific libraries.

5N28. Advanced Laboratory Stress-Strain Testing of Geomaterials. - Edited by F Tatsuoka, S Shibuya, and R Kuwano. Balkema Publ, Brookfield VT. 2001. 340 pp. ISBN 90-2651-843-9. $129.00.

Recent developments in the measurement and interpretation of advanced laboratory stress-strain testing of geomaterials are described in this book, together with a collection of case histories in applying the test results. Most of the articles were produced through seven-year activities from 1994 to 2000 of the Technical Committee No. 29 on Stress strain testing of geomaterials in the laboratory of the International Society for Soil Mechanics and Geotechnical Engineering. The book includes detailed testing procedures of the advanced laboratory stress-strain testing of geomaterials including the triaxial and torsional shear tests, which are relevant to the geotechnical design in general and the prediction of ground deformation and structural displacement; the results obtained from a series of international round robin tests (static and dynamic tests) on clay, sand, and soft rock and their interpretation; the link between the results from static tests (monotonic and cyclic loading) and dynamic tests (the sonant-column tests and the bender elements tests); country reports on the stress-strain testing in the laboratory in several countries; etc.

5N29. ASM Handbook Volume 21: Composites. - Edited by DB Miracle and SL Donaldson. ASM Int, Materials Park OH. 2001. 1100 pp. ISBN 0-87170-703-9. $198.00.

This handbook reflects the technical progress in the field of composites over the past 15 years. Information on OMCs has been updated to reflect improvements in low-cost manufacturing technologies and significantly expanded applications in areas such as infrastructure and marine structures. Progress in MMCs has been dramatic since the previous edition, and new information on these materials provides an up-to-date comprehensive guide to MMC processing, properties, applications, and technology. CMCs have also entered service in a number of applications since the previous edition, and these advances are described in the new handbook.

Titles are as follows: Introduction to composites; Constituent materials; Engineering mechanics, analysis, and design; Manufacturing processes; Post-processing and assembly; Quality assurance; Testing and certification; Properties and performance; Product reliability, maintainability, and repair; Failure analysis; Recycling and disposal; Applications and experience; a glossary; and an index.

5N30. Deployable Structures: Analysis and Design. - CJ Gantes *(Civil Eng Dept, Natl Tech Univ, Athens, Greece)*. WIT Press, Southampton, UK. 2001. 365 pp. ISBN 1-85312-660-8. $198.00.

Research into and design of deployable structures requires the combination of many skills including knowledge of traditional mathematics, understanding of nonlinear structural behavior, use of modern numerical methods of simulation, and a great deal of engineering ingenuity.

Accessible to practicing structural engineers and graduate students with no previous knowledge of the field, this book formulates and solves the complex engineering design problems with which deployable structures are associated. It also presents the issue of design of snap-through type deployable structures in an organized way which will be of interest to more experienced readers. Up-to-date practice and recent research results are highlighted throughout.

Contents include Overview—Introduction, Earth-based deployable structures, Deployable structures for space applications; Snap-Through Type Deployable Structures—Introductory remarks, Geometric design, Structural analysis, Design methodology, Design examples, Bibliography, and World wide web sites of related interest.

5N31. Electromagnetic Nondestructive Evaluation (V). Studies in Applied Electromagnetics and Mechanics, Vol 21. - Edited byJ Pavo, G Vertesy, T Takagi, and SS Udpa. IOS Press, Amsterdam, Netherlands. 2001. 342 pp. ISBN 1-58603-155-4. $105.00.

The book is a collection of papers on Electromagnetic Non-Destructive Evaluation. Recent developments are discussed, up-to-date information is provided, and the implications of innovations for future inspection practice are also considered in this field. Both the basic science and early engineering developments in the field are emphasized. Topics covered are: New developments in electromagnetic nondestructive testing; Analytical and numerical modeling of electromagnetic NDE phenomena; Solutions to NDE inverse problems; Evaluation of material degradation in ferromagnetic structures; Advanced sensors; Industrial applications of NDE; and Benchmark problems and solutions.

5N32. FLAC and Numerical Modeling Geomechanics - 2001. Proc of 2nd Int FLAC Symp, Lyon, Oct 2001. - Edited by D Billaux, X Rachez, C Detournay, and R Hart. Balkema Publ, Brookfield VT. 2001. 432 pp. ISBN 90-265-1859-5. $129.00.

FLAC and FLAC3D are explicit finite difference computer codes for geomechanics applications. FLAC has been distributed by ITASCA Consulting Group since its first commercial release in 1986, and joined by FLAC3D in 1994.

This volume contains a collection of 54 papers selected for presentation at the symposium. The contributions cover a wide range of topics from engineering applications to theoretical developments in the areas of embankment and slope stability, mining, tunneling, soil and structure interaction, dynamic analysis and constitutive models.

This proceedings illustrates the variety of FLAC and FLAC3D applications in geomechanics. It provides descriptions of both engineering applications and theoretical developments and may be used as a guide to help FLAC and FLAC3D users in their geotechnical analysis.

5N33. Formal Engineering Design Synthesis. - Edited by EK Antonsson *(California Inst of Tech)* and J Cagan *(Carnegie Mellon Univ, Philadelphia PA)*. Cambridge UP, Cambridge, UK. 2001. 470 pp. ISBN 0-521-79247-9. $100.00.

This book reviews the state of the art in formal design synthesis methods. It also provides an in-depth exploration of several representative projects in formal design synthesis and examines future directions in computational design synthesis research. The chapters are written by international experts in engineering and architectural design. Among topics covered are shape grammars, architectural design, evolutionary techniques, kinematic design, chemical and electronic design, MEMS design, design compilation, function synthesis, and the use of artificial intelligence in synthesis.

5N34. Frontiers of Rock Mechanics and Sustainable Development in the 21st Century. Proc of 2nd Asian Rock Mechanics Symp, Beijing, Sept 2001. - Edited by Sijing Wang, Bingjun Fu, Zhongkui Li. Balkema Publ, Brookfield VT. 2001. 706 pp. ISBN 90-2651-851-X. $159.00.

The scientific contributions presented at the symposium are covered in this proceedings. With the main theme of *Frontiers of Rock Mechanics and Sustainable Development in the* 21st *Century*, the volume consists of the following sections: Rock mechanics testing and characterization; physical, numerical modeling and, monitoring systems in rock engineering; rock mechanics and rock engineering related to resources, environment, and sustainable development; artificial intelligence, information systems, and nonlinear dynamics in rock mechanics and rock engineering; new design, construction methods, and case histories of major projects. The symposium papers cover topics related to the developments and the state of the art in rock mechanics and rock engineering not only in Asia, but all over the world.

5N35. Handbook of Materials Behavior Models, 3-Volume Set. - Edited by J Lemaitre *(l'Univ de Paris, France)*. Academic Press, San Diego. 2001. 1200 pp. ISBN 0124433413. $950.00.

This is the first-of-a-kind reference-handbook that deals with nonlinear models and properties of materials. This comprehensive reference of research in the materials modeling field is divided into three volumes: 1) Deformation of Materials, 2) Failures in Materials, and 3) Multiphysics Behavior.

5N36. Inelastic Analysis of Structures under Variable Loads: Theory and Engineering Applications. Solid Mechanics and its Applications, 83. - Edited by D Weichert *(Inst fur Allgemeine Mechanik, Rheinisch-Westfalische Technische Hochschule, Aachen, Germany)* and G Maier *(Dept of Struct Eng, Tech Univ (Politecnico), Milan, Italy)*. Kluwer Acad Publ, Dordrecht, Netherlands. 2001. 388 pp. ISBN 0-7923-6645-X.

The question of whether a structure or a machine component can carry the applied loads, and with what margin of safety, or whether it will become unserviceable due to collapse or excessive inelastic deformations, has always been a major concern for civil and mechanical engineers. The purpose of this book is to present state-of-the-art methods which provide conceptual and computational means to answer this technologically crucial question without analyzing the evolution of the system under monotonic or variable repeated loads.

The focus is on recent developments which are classified as follows:

- Adaptation of the general theoretical achievements to specific types of structures and, at the micro-scale, to heterogeneous materials;
- Generalization of the basic theory to dynamics, ie, to the time-dependence due to inertia and damping forces;
- Reformulation of the fundamental theorems in the broader frame of geometrically nonlinear theory of solids and structures;
- Allowing for more sophisticated models of inelastic material behavior, including nonlinear hardening and softening, non-associated flow rules, viscous effects, multi-phase poro-plasticity, and material damage;
- Development of computational procedures and specific ad-hoc algorithms by which direct methods can be efficiently used to solve large-scale industrial problems.

5N37. Initiatives of Precision Engineering at the Beginning of a Millennium. Proc of 10th Int Conf, July 2001, Yokohama, Japan. - Edited by I Inasaki *(Dept of Syst Des, Keio Univ, Yokohama, Japan)*. Kluwer Acad Publ, Norwell MA. 2001. 977 pp. ISBN 0-7923-7414-2. $175.00.

This proceedings includes 190 contributed papers from 10 countries. Major subjects covered by this book include: Advanced manufacturing systems; ultra-precision machining and micro machining; nanotechnology for fabrication and measurement; chemo-mechanical processes; rapid prototyping technology; new materials and advanced processes; computer-aided production engineering; manufacturing process control; planning and scheduling for production, and CAD/CAM/CAE.

5N38. IUTAM Symposium on Creep in Structures. Held in Nagoya, Japan, April 2000. - Edited by S Murakami and N Ohno *(Nagoya Univ, Japan)*. Kluwer Acad Publ, Dordrecht, Netherlands. 2001. 544 pp. ISBN 0-7923-6737-5.

This proceedings contains 48 innovative papers presented at the symposium, in which 91 participants from 15 countries participated to consolidate the development of creep research since 1990 and to discuss the new horizons in this fundamental field of applied mechanics in the coming century. The papers deal with: 1) physical and microstructural process of creep, viscoplasticity, and creep damage related to their modeling; 2) elaborated constitutive equations of time-dependent deformation and damage; 3) creep damage and fracture of engineering materials and structures; 4) computational modeling, simulation, analysis, and design of structures in creep; and 5) creep of polymers, composites, and heterogeneous materials.

5N39. Mathematics of Thermal Modelling: An Introduction to the Theory of Laser Material Processing. - JM Dowden *(Univ of Essex, UK)*. Chapman and Hall/CRC, Boca Raton FL. 2001. 304 pp. ISBN 1-58488-230-1. $79.95.

This book introduces the mathematics needed to formulate and exploit the physical principles important to modeling various aspects of laser material processing. The author shows how to gain insight by constructing and analyzing simple models. He demonstrates how to extract qualitative information from the models, how the underlying principles can be extended to more complex modeling, and how these principles can be applied to processes such as laser welding, surface treatment, drilling, and cutting.

5N40. Mesoscopic Theory of Polymer Dynamics. - VN Pokrovskii *(Dept of Phys, Univ of Malta, Msida)*. Kluwer Acad Publ, Dordrecht, Netherlands. 2001. 232 pp. ISBN 0-7923-6682-4.

This monograph contains the fundamentals of the theory and gives a compact and consistent picture of the different relaxation phenomena in very concentrated solutions and melts of linear polymers (diffusion, neutron scattering, viscoelasticity, and optical birefringence) from a macromolecular point of view and without any specific hypotheses. It can be considered as complementary reading to the classic textbook by Doi and Edwards. The original approach taken to the problem allows us to understand why numerous attempts to find the 3.4-index law for the viscosity coefficient of linear polymers in the frame of the reptation-tube model were doomed to fail, and have failed during the last 20 years. It also helps us to derive the proper constitutive relation for polymers of different architecture.

The monograph can be used as a textbook for graduate students with some background in physics and mathematics. It could provide material for a one- or two-semester graduate-level course in polymer dynamics. The monograph presents topics in a self-contained way that makes it a suitable reference book for professional researchers in the fields of rheology, polymer science, polymer engineering, and material science.

5N41. Nontraditional Methods of Sensing Stress, Strain, and Damage in Materials and Structures: Second Volume. STP 1323. - Edited by GF Lucas *(Jet Edge)*, PC McKeighan *(SWRI)* and JS Ransom *(Fatigue Tech Inc)*. ASTM. 2001. 213 pp. Softcover. ISBN 0-8031-2882-7. $83.00.

This volume examines new and nontraditional methods of measuring mechanical properties in materials and structures including imaging systems to infer deformation fields, acoustic emission techniques, and different applications and sensors. Many of these methods allow measurement of features and parameters that in the past have been difficult, if not impossible, to sense and distinguish.

Twelve peer-reviewed papers are divided into three sections and a panel discussion summary covering: Fracture mechanics and structural integrity, Damage evolution and measurement, Strain and displacement measurement techniques, and Current status and future sensor development.

5N42. Plasticity and Elasticity of Cryocrystals: Handbook. - AI Prokhvatilov *(B Verkin Inst for Low-Temperature Phys and Eng, Natl Acad of Sci, Khar'kov, Ukraine)*. Begell House, New York. 2001. 237 pp. ISBN 1-56700-161-0. $85.50.

In this handbook, the data on mechanical behavior and elasticity are collected, peculiar to the simplest forms of the following molecular crystals: inert elements (argon, krypton, xenon, neon); molecular substances formed by nitrogen, oxygen, carbon monoxide, ammonia, deuteroammonia, methane, deuteromethane, carbon dioxide; and quantum crystals of the isotopes of hydrogen or helium.

The book demonstrates the experimental data on uniaxial tension or compression strength and ductility, hardness, extrusion, impact toughness, creep, and stress relaxation. It also delivers the elasticity characteristics like Young's modulus, shear modules, Poisson's ratio, and elastic constants. The quantitative data are also given on the thermodynamic characteristics of plastic-deformation processes, lattice imperfections (dislocations, vacancies, and stacking faults), as well as on the effect of isotopic or chemical impurities on the elasticity or plasticity characteristics of the simplest molecular crystals.

5N43. Processing and Fabrication of Advanced Materials IX. - Edited by TS Srivatsan, RA Varin, and KA Khor. ASM Int, Materials Park OH. 2001. 322 pp. ISBN 0-87170-738-1. $123.00.

This book includes 24 papers covering the following topics: Ceramics (3 papers), Coatings (4), Ferrous and nonferrous alloys (6), Intermetallics (3), Metal-matrix composites (3), and Nanophase and fine-grained materials (5).

5N44. Rock Mechanics in the National Interest. Proc of 38th US Rock Mechanics Symp, Washington DC, July 2001. - Edited by D Elsworth, JP Tunucci, and KA Heasley. Balkema Publ, Brookfield VT. 2001. 1570 pp. 2-Vol set. ISBN 90-2651-827-7. $197.50.

This proceedings volume showcases all aspects of the science and engineering of rock mechanics in 210 contributions drawn from all inhabited continents of the world. These contributions span a broad symposium theme including the many aspects of rock mechanics that relate to environmental protection, national security, the safe and effective extraction and utilization of natural resources, the development of civil infrastructure, and protection from the effects of natural hazards. Divided into seven sections, this proceedings deals with rock mechanics applied to petroleum recovery, mining, waste repositories, joints and fractures, rock mass characterization, infrastructure, and modeling.

5N45. Soft Clay Behavior Analysis and Assessment. - TS Nagaraj and N Miura. Balkema Publ, Brookfield VT. 2001. 332 pp. ISBN 90-5809-329-8. $90.00.

This book presents simple working methods for systematic analysis and parametric assessment of soft clays at engineering level. It is believed that employing these approaches would be commensurate with the computational tools available and expertise already attained to solve practical problems involved with soft clays both in their natural and induced cemented states.

To circumvent the limited benefits of natural cementation, it can also be induced at the same in-situ state by cementing agents by In-situ deep mixing and Jet grouting as ground engineering methods, extensively employed presently in Japan and in many coastal regions of the world. The development at different rest periods discussed in this treatise is in tune with the rapid advancements already achieved in plant and machinery along with associated field techniques.

Topics include soils as engineering materials; soft clay engineering; development of the basic framework for analysis; uncemented saturated soft clays — stresses and time effects; naturally cemented soft clays, and induced cemented soft clays. References and an index are also provided.

5N46. Soil Mechanics and Geotechnical Engineering, Eleventh Asian Regional Conference, Volume 2. Held in Seoul, Korea, Aug 1999. - Edited by Sung-Wan Hong, ES Lee, MW Lee *(Piletech, Kyunggi-do, Korea)*, YY Kim, and YS Jang *(Dept of Civil and Env Eng, Dongguk Univ, Seoul, Korea)*, and CS Yoo. Balkema Publ, Rotterdam, Netherlands. 2001. 913 pp. ISBN 90-5809-055-8.

This volume contains 135 papers contributed to the conference. Contributions came from the Asian region such as Bangladesh, China, Hong Kong, India, Iran, Japan, Kazakhstan, Korea, Malaysia, Nepal, Pakistan, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam as well as from other parts of the world.

The contributions are classified into six themes: Engineering properties of soils and rocks; deep and shallow foundations; underground excavation and tunneling; earth structures and slopes; environmental geotechnics; and soil dynamics and earthquake engineering.

5N47. XVth International Congress on Soil Mechanics and Geotechnical Engineering. Proc Istanbul, Turkey, August 2001. - Edited by Publications Committee. Balkema Publ, Brookfield VT. 2001. 3200 pp. 4-Vol set. ISBN 90-2651-838-2. $890.00.

This proceedings is of interest for researchers and practicing engineers and reflects the state of the art and state of practice of soil mechanics and geotechnical engineering.

Topics covered include testing and property characterization of geomaterials; foundations and retaining structures; tunneling and underground space development; ground improvement and reinforcement; environmental issues of geotechnical engineering; and design, construction, and maintenance of transportation infrastructure. Volume 4 contains six state-of-the-art reports, the Terzaghi Oration, Heritage Lecture, and four invited lectures and summaries of the discussion session and workshops held during the conference.

Asymptotic Methods in the Buckling Theory of Elastic Shells. - PE Tovstik and AL Smirnov *(St Petersburg State Univ, Russia)*. World Sci Publ, Singapore. 2001. 347 pp. ISBN 981-02-4726-5. $78.00. (Under review)

Linearized Theory of Elasticity. - WS Slaughter *(Dept of Mech Eng, Univ of Pittsburgh, Pittsburgh PA 15261)*. Birkhauser Boston, Cambridge MA. 2002. 543 pp. ISBN 0-8176-4117-3. $79.95. (Under review)

V. MECHANICS OF FLUIDS

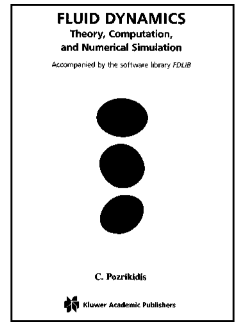
5R48. Fluid Dynamics: Theory, Computation, and Numerical Simulation. - C Pozrikidis *(Dept of Appl Mech and Eng Sci, Univ of California, La Jolla CA 92093-0411)*. Kluwer Acad Publ, Norwell MA. 2001. 675 pp. ISBN 0-7923-7351-0. $140.00.

Reviewed by DK Gartling (Comp Fluid Dyn, Sandia Natl Labs, MS 0826, Albuquerque NM 87185-5800).

There are a wide variety of undergraduate fluid dynamics texts available, and all claim to have some unique attribute that makes them the better choice for the classroom. The aim of the present book is to merge the study and use of numerical methods with the theory and solutions of classical fluid dynamics. The idea is quite reasonable given that so much of current engineering flow analysis is based on computer simulation. However, it is not clear that a combination of two very extensive subjects can be adequately addressed in a single text. This book has a very thorough treatment of isothermal, low speed fluid dynamics at the undergraduate level. The topics on numerical methods are considered in a much more superficial manner though, in many cases, they are integrated nicely with the fluid dynamics applications. The text is coupled to a software library that can be downloaded and run on modest hardware. This is a very appealing feature in that it permits the student to conveniently evaluate and study a variety of flow problems and hopefully gain a better physical feeling for fluid dynamics.

The first two chapters are extensive and cover all of the standard topics associated with fluid kinematics including coordinate systems, deformations, streamlines, streaklines and particle paths, vector analysis, material derivatives, mass conservation, and the continuity equation. Numerical techniques for simple ordinary differential equations, interpolation, and numerical differentiation are introduced as part of the solution methods for problems in kinematics. Chapter 3 continues with irrotational flows and the formulation and solution of potential problems. Point singularities and distributions for the potential field are discussed, and the finite difference method for Laplace's equation is introduced. Sections on derivative approximations, linear algebraic equations, boundary condition imposition, and matrix solvers are included among the numerical topics.

Chapter 4 introduces forces and stresses and the ideas of viscosity and constitutive relations for Newtonian and non-Newtonian fluids. The next chapter considers problems in hydrostatics including forces on submerged objects and a variety of free surface and contact angle problems. The numerical methods described in conjunction with these problems include Newton's method for a single equation and shooting methods for ordinary differential equations. Chapter 6 returns to purely fluid mechanics topics and is concerned with the equations of motion in both differential and integral form. Boundary conditions are described, and there are sections on the Euler and Navier-Stokes equations as well as the vorticity transport equation. The seventh chapter is quite lengthy and provides a very complete catalog of analytic and semi-analytic solutions for tube and channel flows and simple flows next to walls. The computer work associated with this chapter is primarily the evaluation of complex solutions with variations in geometric and flow parameters.



The finite difference method for incompressible, viscous flows is the main subject of Chapter 8. Initially, difference methods are introduced for the solution of simplified flow equations. The second part of the chapter considers primitive variable and vorticity transport formulations for the two-dimensional driven cavity problem. Though the illustrations and graphics throughout the text are generally good, the velocity vector plots in this chapter are not very helpful. The next two chapters consider flows at the extremes in Reynolds number. The low Reynolds number chapter discusses all of the standard lubrication flows, film flows, corner flows, and point source methods and also introduces the finite volume method. The high Reynolds number chapter covers the classic boundary layer methods and flow stability, and introduces turbulence and mathematical descriptions of turbulence. Vortex motions in the absence of viscosity form the subject of Chapter 11 with sections on point vortices, contour dynamics, and the Biot-Savart integral. The last chapter deals with panel methods for external inviscid flows. The numerical work for these last few chapters mostly involves the application of methods described in previous chapters. The book concludes with an appendix describing the contents of the available software library and a marginally adequate index.

As an undergraduate text on fluid dynamics, this is a very complete and well-written book. The numerical methods featured in the book are elementary, but are worthwhile in the context of undergraduate study. The software available with the book is also a useful adjunct for study. *Fluid Dynamics: Theory, Computation, and Numerical Simulation* is certainly recommended for consideration as a classroom text. Those with an interest in fluid mechanics at the graduate or post-graduate level might find the book a useful reference; those seeking a treatise on numerical methods or computational fluid dynamics will find the text of limited value.

5R49. Inviscid Incompressible Flow. - JS Marshall *(Dept of Mech Eng, Iowa Inst of Hydraul Res, Univ of Iowa, Iowa City IA)*. Wiley, New York. 2001. 378 pp. ISBN 0-471-37566-7. $90.00.

Reviewed by TF Balsa (Dept of Aerospace and Mech Eng, Univ of Arizona, Tucson AZ 85721).

When the invitation came to review this book, this reviewer was very surprised by its title. Curiosity, more than anything else, drove me to review the book. Such classical subject! Since several excellent, scholarly, and comprehensive treatments already exist, both in the fluid mechanics as well as in the aerodynamics contexts, this reviewer saw little need for another book. Consider, for example, *An Informal Introduction to Theoretical Fluid Mechanics* by Lighthill.

The book under review is primarily a textbook, most suitable for an introductory graduate-level course in fluid mechanics. The book is attractively prepared, relatively free from obvious major errors, contains illustrative examples (more so in the first half than in the second half), provides a good set of homework problems, including some focusing on computational projects, and supplies a partial list of modern references at chapters' end. Even the best of students will be challenged by the content. The book's secondary focus, complementing the classical concepts and results, may be labeled as *vorticity methods*.

The book (378 pages long; including one short appendix on the geometry of orthogonal coordinate systems) is on theoretical fluid mechanics with some computational flavor. Many of the main results are stated in the form of theorems. Reference to experimental data or comparison with such is virtually absent. This is very unwise in the subject. For example, Figure 11.8 displays computational contours of vorticity in the roll-up process in a shear layer. This reviewer thinks experimental data and flow visualization pictures would strengthen the presentation.

The 16, well-organized and relatively brief chapters span the usual topics such as: kinematics, the equations of motion, vorticity and pressure theorems, examples of two- and three-dimensional potential flows (ie, sources, dipoles, etc) and forces on bodies in these flows. The chapters on two-dimensional flow are treated by the use of complex variables. There is more emphasis on flows with concentrated vorticity (ie, vortex tubes, sheets, etc) than in most similar textbooks. This is the secondary focus mentioned above. There is also some discussion of discontinuities, flow instability, and interfacial wave motion. The latter two, treated at the end of the book, are sketchy.

It seems to me that Chapter 6 on velocity representations (ie, velocity potential, Laplace equation, the Biot-Savart equation, and far fields) breaks up the continuity in the presentation of fluid mechanics. This reviewer thinks a better place for this material would be in an appendix; this comment should also apply to a review of vectors and tensors in Chapter 1.

The vorticity transport theorems (Ch 7) are undeniably the most important results in fluid mechanics. The formal analysis is competently done—no surprises. Yet the issue of why vorticity (other than that generated by the baroclinic effect) appears in an inviscid fluid motion started from rest is not discussed deeply. This is unfortunate. Clearly, some connection must be made to large Reynolds number flows, viscous boundary layers, and the like. Establishing a stronger link between vorticity and viscous effects, even qualitatively, is imperative (see the attempt on pages 3-4) so this connection becomes engrained in the fresh and open minds of students. Otherwise, inviscid incompressible fluid mechanics is a beautiful and sterile subject of the pre-Prandtl era. The book could be improved in this general direction. For example, the Index contains no entry under *separation*.

All in all, this is a good introductory book, and this reviewer would not hesitate to use chapters of it in some courses. Obviously, the sections to be covered are at the discretion of the instructor. There are some places where the presentation should be improved. Here are three examples, ranging from the trivial to the bothersome:

1) The cross product of unit vectors is defined as $\mathbf{e}_i \times \mathbf{e}_j = \varepsilon_{ijk}\mathbf{e}_k$. Therefore the expression written in Eq (2.3.2) for $\mathbf{u}\times\mathbf{v}$ is inconsistent with this.

2) The derivation of the rate of change of a material volume can be done simply by the use of a sketch and a physical argument. The formal derivation (Section 3.4) is unnecessarily dry. There are other instances where more intuitive derivations should be given.

3) Finally, the relationship between the doublet and vortex sheet strengths (Eq 11.6.13) is incorrect. For one thing, ∇ is a spatial operator, so the application of this to a quantity which is defined only on a surface is unclear.

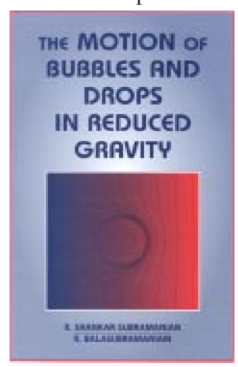
There is also a major omission, namely, the control volume analysis of forces and moments acting on bodies that shed a trailing vortex system. This analysis would place the D'Alembert paradox in the proper perspective and would identify the concept of induced drag. This consideration would also bring some life to *kinetic energy* and *impulse*.

Again, on balance, *Inviscid Incompressible Flow* is a fine book on the classical material. It also contains some more recent (10-20 year old) vorticity-related results that are normally not found in textbooks at this introductory level for graduate students. Any student who has mastered this material will have an excellent understanding of inviscid incompressible fluid mechanics. The person will also gain some understanding of discrete methods to track regions of concentrated vorticity and the limitations of the methods. On the last point, even an expert may gain a quick overview of the available techniques.

5R50. Motion of Bubbles and Drops in Reduced Gravity. - RS Subramanian *(Clarkson Univ, Potsdam NY)* and R Balasubramaniam *(Natl Center for Microgravity Res on Fluids and Combust, NASA John H Glenn Res Center, Cleveland OH)*. Cambridge UP, Cambridge, UK. 2001. 471 pp. ISBN 0-521-49605-5. $100.00.

Reviewed by N Clark (Dept of Civil Eng, Eng, and Mineral Resources, West Virginia Univ, 125 Eng Sci, PO Box 6106, Morgantown WV 26506-6106).

The existence of bubbles and drops is predicated on the presence of interfacial tension, but their motion is more often than not caused by gravity. The authors have teamed up to produce this book that examines the behavior of bubbles and drops without influence of the earth's pull. The authors observe that bubbles and drops are frequently encountered in spacecraft laboratory experiments with which they have direct experience. Although this topic is highly specialized, their book will double as a broader reference because it also dwells on related multiphase issues.



The book is divided into four parts. Part 1 commences with a careful review of the governing equations, discussion of surfactants and surface tension, and an introduction to reduced gravity in spacecraft. The authors continue in Part 2 on the topic of motion of single bubbles and drops. They consider the cases of motion when inertia is negligible, and when inertial effects are moderate. Drops and bubbles at high Reynolds' numbers are also treated. The authors provide fundamental analyses to describe the motion of an isolated drop caused by surface tension gradients, which are often induced by variations of temperature across the field (thermocapillary motion). Careful attention is paid to limiting cases, such as when convective energy transport is small, or else dominant, and surfactants are discussed in appropriate detail. Illustrations in this section are well considered and provide a valuable interpretation of the theory.

In Part 3, the authors address interactions of bubbles and drops. This topic is of interest firstly because it is necessary in designing single drop experiments to estimate the influence of neighboring drops and avoid their influence by choosing sufficiently large drop spacing. Secondly, the interaction of drops is important in understanding the circumstances leading to coalescence. The authors carefully explain the difficulties that arise in tackling a theoretical description of drops under the influence of a neighboring boundary. Part 3 amplifies the analysis well by providing useful illustrations, such as those of streamlines in the vicinity of interacting bubbles. The authors present relevant experimental data periodically to demonstrate agreement with theory. Part 4 discusses interphase mass transfer. Analytic solutions are developed and compared with numerical computations. This section provides a strong basis for necessary future research. The last chapter deviates a little from the overall theme, but provides a useful account of flows driven by variations in surface tension.

This book is thorough and rigorous. With 400 references, the work of prior researchers is well acknowledged. The Table of Contents, Index, and Introductions to the chapters make the material easy to navigate, and the authors have taken the trouble in the text to refer the readers to related sections elsewhere in the book. Motion of Bubbles and Drops in Reduced Gravity will be of value to applied mathematicians, physicists, and fluids engineers working in the fields of reduced gravity or multiphase systems, and may impact a number of materials researchers. *Motion of Bubbles and Drops in Reduced Gravity* is an essential purchase as a reference text for libraries at universities and research laboratories, but is too specialized as a graduate text at all but a few universities. However, those engaged in this challenging field are well advised to place copies on their bookshelves.

5R51. Navier-Stokes Equations and Turbulence. Encyclopedia of Math and its Applications, Vol 83. - C Foias *(Dept of Math, Indiana Univ, Bloomington IA)*, O Manley *(Consultant)*, R Rosa *(Univ Fed do Rio de Janeiro, Rio de Janeiro, Brazil)*, and R Temam *(Univ Paris-Sud, Orsay, France)*. Cambridge UP, New York. 2001. 347 pp. ISBN 0-521-36032-3. $90.00.

Reviewed by J Meng (NAVESEA, Keyport WA 98345).

This is an excellent book for interdisciplinary graduate level education and as a reference book for the turbulence research community. This book is the first to build a comprehensive common ground between themathematics and turbulence communities in terms of demonstrating that NSE constitutes a comprehensive model of incompressible flows. The major contributions are in showing how: The Kolmogorov spectrum for three dimensional turbulence; and Kraichnan spectrum for two-dimensional turbulence follow naturally from the NSE; the intermittency of turbulent flows is related to the fractal nature of energy dissipation in three dimensions; and on providing a bound on the sufficient number of degrees of freedom for this fluid flow.

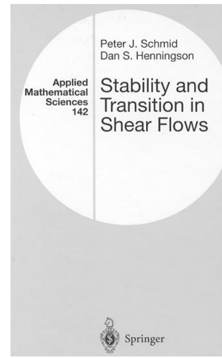
This book provides a well-founded conviction that further understanding of turbulence is determinable from the NSE without invoking additional ad hoc assumptions so that more insights into the nature of turbulence can be gained from studying the intrinsic properties of the NSE which historically could not be arrived at by intuitive considerations. *Navier-Stokes Equations and Turbulence* serves as an excellent starting point to inspire scholars to take the next step of tying together the theoretical aspects with the known experimental phenomenology, such as the repeatable patterns of wall turbulence and free shear flows. Once accomplished, it would give tremendously more insights to the physical relevance and will no doubt provide even more impetus of progress in solving one of the greatest challenges in science.

5R52. Stability and Transition in Shear Flows. Applied Mathematical Sciences, Vol 142. - PJ Schmid *(Appl Math Dept, Univ of Washington, Seattle WA 98195-0001)* and DS Henningson *(Dept of Mech, Royal Inst of Tech, Stockholm, S-100 44, Sweden)*. Springer-Verlag, New York. 2001. 556 pp. ISBN 0-387-98985-4. $79.95.

Reviewed byReviewed by DF Jankowski (Dept of Mech and Aerospace Eng, Arizona State Univ, PO Box 875506, Tempe AZ 85287-5506).

Hydrodynamic stability is concerned with the fate of disturbances imposed on a basic flow. Since, in some flow situations, the initial growth of disturbances can lead to a transition to turbulence, the subject is particularly attractive to certain members of the fluid-dynamics community. The audience for this particular treatment of stability and transition is loosely defined in the preface where it is stated that the ‘‘book is foremost intended for researchers and graduate students with a basic knowledge of fluid dynamics.’’ The necessary level of this knowledge can only be inferred, and there is no mention of the considerable specialized mathematical knowledge that is also needed to fully understand the wide range of sophisticated mathematical tools that are used routinely in its nine chapters of nearly 500 pages, well over 1000 numbered equations and over 200 figures. In comparison to the emphasis on mathematical analysis and its associated modeling, the attention devoted to physical insights or experimental verification is limited, with the exception of the final chapter.

The tone of the book's material on stability is immediately apparent in the brief first chapter, Introduction and General Results, wherein the general nonlinear disturbance equations and the kinetic-energy evolution equation are derived, and four definitions of temporal stability and four critical Reynolds numbers are introduced. A useful caution about the difference between the temporal and spatial evolution of disturbances is also provided. Three of the temporal definitions are related to the behavior of disturbance kinetic-energy in the asymptotic limit of large time. In later chapters, considerable attention is paid to short-time disturbance behavior. In the caption of Figure 1.2, ‘‘above Re_L: Possible instability’’ appears, contradicting a statement on page 6. This chapter is followed by the four chapters of Part I, *Temporal Stability of Parallel Shear Flows*, which presents the authors' view of the ‘‘fundamental topics underlying stability theory,’’ and the four chapters of the longer Part II, *Stability of Complex Flows and Transition*, which ‘‘covers more advanced topics.’’



An involved theoretical picture continues to develop in the second chapter, Linear Inviscid Analysis, which considers the linear stability of planar parallel flows with the effects of viscosity ignored. This modeling might have been motivated by noting that the effect of viscosity is, at first glance, expected to be stabilizing; a counter example is later mentioned in Section 3.2. The chapter begins with an examination of the pertinent governing equations for infinitesimal wave-like disturbances, the development of some related general results, and several idealized example solutions. It closes with a treatment of the inviscid initial-value problem for the time evolution of infinitesimal disturbances. The differences between approaches based on eigenvalue (modal) problems and initial-value (non-modal) problems are emphasized throughout the book. The third chapter, Eigensolutions to the Viscous Problem, roughly follows the pattern of the first portion of Chapter 2 although the inclusion of viscosity leads to a broader, more complicated, and often more subtle presentation. The primary governing equation for infinitesimal wavelike disturbances (the Orr-Sommerfeld (OS) equation) imposed on plane parallel flows is derived, and some related general results are presented. The corresponding eigenvalue problem is also derived for fully-developed flow in a pipe. Specific numerical results are presented and discussed for this flow, and for plane Couette flow, plane Poiseuille flow, and Blasius boundary-layer flow, a nearly-parallel flow. For the later two examples, a certain finite critical Reynolds number (Re_L from chapter 1) can be obtained. Experiments designed to verify these results are not mentioned. Some suitable numerical techniques for the OS equation and tables of eigenvalues for the four classical examples are provided in Appendix A. The chapter closes with topics related to various mathematical aspects of the OS equation, its adjoint equation, solutions, and ways of determining information about them. The next chapter, Viscous Initial Value Problem, introduces its subject by studying a simple model problem. Algebraic growth is found to be possible for small time and is attributed to the mathematical structure of the model system. The rest of the chapter pursues this possibility and related complications and extensions at considerable length for the four prototype flows mentioned earlier. It seems that Re_G of Section 4.6.2 should be Re_E of Section 5.6. Chapter 5 extends the discussion into the complicated realm of Nonlinear Stability. An analysis of a nonlinear model problem is followed by the derivation of the governing equations for finite-amplitude disturbances imposed on a parallel shear flow and selective (''mathematically advantageous'') treatments of the corresponding nonlinear initial-value problem. This is not easy going. The last topic of the chapter is energy stability theory about which a small comment can be made: Re_E is determined by solving the eigenvalue problem of Section 5.6.2, while a lower bound to Re_E follows from the relaxed eigenvalue problem associated with Eq. (5.153).

Chapter 6, Temporal Stability of Complex Flows, the first chapter of Part II, moves away from the simple incompressible shear flows of Part I to a series of examples that involve new physical features and varying levels of mathematical complexity: similarity boundary layers with adverse and favorable pressure gradients; three-dimensional boundary layers with cross-flow; channel flows with span-wise rotation and slight streamline curvature; free-surface flow down an inclined plane; channel flow with an oscillatory pressure gradient; general time-dependent parallel basic flow; and the inclusion of compressibility in boundary layers. It is not possible to discuss all of the related issues to these examples in the space alloted. The next chapter, Growth of Disturbances in Space, is the longest in the book and contains 400 equations. Its issues are the particular complications associated with disturbances that grow spatially. Differences and connections between the temporal and spatial cases are effectively displayed with model problems and with some specific results for channel and boundary-layer flows. This is followed by a treatment of absolute and convective instability, and approximate applications to the plane wake behind a circular cylinder and the classical rotating-disk flow. The spatial initial-value problem, a multi-faceted look at non-parallel effects, and a brief look at receptivity theory close the chapter. The later topic brings the discussion somewhat closer to the transition process since it involves the study of how ever-present disturbances are drawn into a boundary layer and how it responds.

The subject of the short Chapter 8 is Secondary Instability, which considers the fact that the growth of a disturbance can, in certain circumstances, lead to an altered basic flow that has its own set of stability conditions. Some of the ideas presented are of direct relevance to several of the special examples of Chapter 6. The tone of the final chapter, Transition to Turbulence, is more descriptive and tutorial in nature than the previous eight chapters; there are only seven equations in a chapter that is about 75 pages long. These remarks should not be interpreted as implying that the chapter is somehow less challenging than its predecessors. The goal of this chapter is to connect concepts and results associated with instability to the transition to turbulence. Three possible transition scenarios in a temporal setting are presented in its introductory first section. It is followed by a sequence of sections, which considers the ''complete transition process in spatially evolving flows.'' Results from a number of physical and numerical experiments are routine parts of these sections. The chapter ends with a largely empirical section on transition modeling and a warning about the lack of a general transition model.

Four appendices and a bibliography of over 300 items, including some from 1999 and 2000, close the book. Appendix A, Numerical Issues and Computer Programs, discusses the numerical solution of the classical OS eigenvalue problem for parallel and nearly parallel flows, and provides several MATLAB codes for this purpose. It is followed by two brief appendices that treat some mathematical details. The final appendix contains 14 student problems related to the material of Part I.

Stability and Transition in Shear Flows is an ambitious and personal book, really a monograph because of its in-depth treatment of the two major topics announced in its title. It contains much to learn and think about. With its primary focus on their mathematical side, it has found an appropriate home as a volume in the long established Springer-Verlag series on applied mathematical sciences. Every serious technical library should have a copy as should a limited number of individuals, mostly specialists and those who want to become one. It is not obvious how to use the book in a graduate course since considerable specific background material must be available in order to appreciate the single chapter on transition. Working through the book is not for the light-hearted. An author index and a list of symbols would have helped. In general, the number of ideas, concepts, and special conditions that must be kept track of are close to overwhelming. More motivation and guidance as to the sense in which topics and results are important and how they ultimately relate to transition would have smoothed the way. Unanswered research issues might have been given more direct attention, but astute and careful readers should still be able to uncover some interesting possibilities. In spite of these comments, there is no need for the authors to apologize for the fact that learning about a complicated subject is, in turn, complicated.

5N53. Computational Flow Modeling for Chemical Reactor Engineering. - VK Ranade *(Natl Chem Lab, India)*. Academic Book Collection, Irvine CA. 2001. 480 pp. ISBN 0–12–5769601. $99.95.

This book relates the individual aspects of chemical reactor engineering and computational flow modeling in a coherent way to explain their uses and potential research and practice.

5N54. Computational Fluid Dynamics 2000. Proc of 1st Int Conf, ICCFD, Kyoto, Japan, July 2000. - Edited by N Satofuka *(Dept of Mech and Syst Eng, Kyoto Inst of Tech, Matsugasaki, Sakyo-ku, Kyoto, 606-8585, Japan)*. Springer-Verlag, Berlin. 2001. 810 pp. ISBN 3-540-41459-2. $159.00.

This volume constitutes the proceedings of a conference where the purpose was to bring together scientists, mathematicians, and engineers to review and share recent advances in mathematical and computational techniques for modeling fluid dynamics.

In this volume, there are four invited lectures. The contributed papers follow grouped under 21 topic headings: Adaptive mesh; unstructured grid; mesh generation; compressible flow; hypersonic and reactive flows; unsteady flows; incompressible flows; stability of boundary layer; flows with free surface; numerical techniques; domain decomposition and parallel algorithms; transition and turbulence; lattice Boltzmann method; aeroacoustics; adjoint method; vortex method; two-phase flows; fluid structure interaction; optimization and design; moving boundaries; and level set/VOF. Papers presented in poster sessions appear as Technical Notes.

5N55. IUTAM Symposium on Developments in Geophysical Turbulence. Held Boulder CO, June 1998. - Edited by RM Kerr *(Natl Center of Atmos Res, Boulder CO)* and Y Kimura *(Nagoya Univ, Japan)*. Kluwer Acad Publ, Dordrecht, Netherlands. 2001. 308 pp. ISBN 0-7923-6673-5.

Topics that are emphasized in this proceedings include the physics and mathematics of turbulence, atmospheric and oceanic turbulence, and historical developments.

5N56. Mathematical Fluid Mechanics: Recent Results and Open Questions. Advances in Mathematical Fluid Mechanics. - Edited by J Neustupa *(Dept of Tech Math, Czech Tech Univ, Karlovo nam 13, Praha 2, 121 35, Czech Republic)* and P Penel *(Dept de Math, Univ de Toulon et du Var, BP 132, LaGarde Cedex, 83957, France)*. Birkhauser Verlag AG, Basel, Switzerland. 2001. 268 pp. ISBN 3-7643-6593-5. $89.95.

Mathematical modeling and numerical simulation in fluid mechanics are topics of great importance both in theory and technical applications. The present book attempts to describe the current status in various areas of research. The 10 chapters, mostly survey articles, are written by international specialists and offer a range of approaches to and views of the essential questions and problems. In particular, the theories of incompressible and compressible Navier-Stokes equations are considered, as well as stability theory and numerical methods in fluid mechanics.

5N57. Mathematical Modeling: Case Studies from Industry. - Edited by E Cumberbatch *(Math Clinic, Claremont Grad Univ)* and A Fitt *(Fac of Math Stud, Univ of Southampton, UK)*. Cambridge UP, Cambridge, UK. 2001. 299 pp. Softcover. ISBN 0-521-01173-6.

This book deals with real industrial problems from real industries. Presented as a series of case studies by some of the world's most active and successful industrial mathematicians, this volume shows how the process of mathematical collaboration with industry can not only work successfully for the industrial partner, but also lead to interesting and important mathematics.

A brief introduction summarizes the equations that most of the studies are based upon. Thirteen different problems are considered, ranging from cooking of cereal to the analysis of epidemic waves in animal populations. Throughout the book, the emphasis is on providing useful information to people in industry.

5N58. Numerical Flow Simulation II: CNRS-DFG Collaborative Research Program Results 1998-2000. Notes on Numerical Fluid Mechanics, Vol 75. - Edited by EH Hirschel *(Herzog-Heinrich-Weg 6, Zorneding, 85604, Germany)*. Springer-Verlag, Berlin. 2001. 329 pp. ISBN 3-540-41608-0. $179.00.

This volume contains 19 reports on work that has been conducted since 1998. 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, and Turbulent flows.

Foundations of Fluid Dynamics. - G Gallavotti *(Dept di Fisica, INFN, Univ degli Studi di Roma "La Sapienza," Piazzale Aldo Moro, 2, Roma, 00185, Italy)*. Springer-Verlag, Berlin. 2002. 513 pp. ISBN 3-540-41415-0. $59.95. (Under review)

Micro Flows: Fundamentals and Simulation. - GEM Karniadakis (*Div of Appl Math, Brown Univ, 182 George St, Providence RI 02912)* and A Beskok *(Dept of Mech Eng, Texas A&M Univ, TAMU 3123, College Station TX 77843-3123)*. Springer-Verlag, New York. 2002. 340 pp. ISBN 0-387-95324-8. $69.95. (Under review)

Physical Hydrodynamics. - E Guyon *(Ecole Normale Superieure, Paris, France)*, J-P Hulin *(CNRS Laboratoire Fluides, Automatique et Systemes Thermiques, Univ Paris Sud, Orsay, France)*, L Petit *(Univ de Nice, Sophia Antipolis, France)*, and CD Mitescu *(Pomona Col, Claremont CA)* Oxford UP, Oxford, UK. 2001. 505 pp. Softcover (Hardcover ISBN: 0-19-851746-7, $100.00). ISBN 0-19-851745-9. $50.00. (Under review)

Theory and Applications of Nonviscous Fluid Flows. - RK Zeytounian *(Retired)*. Springer-Verlag, Berlin. 2002. 294 pp. ISBN 3-540-41412-6. $84.95. (Under review)

Vorticity and Incompressible Flow. Cambridge Texts in Applied Mathematics. - AJ Majda *(Courant Inst of Math Sci, New York Univ, New York NY)* and AL Bertozzi *(Duke Univ, Durham NC)*. Cambridge UP, Cambridge, UK. 2002. 545 pp. Softcover. ISBN 0-521-63948-4. $40.00. (Hardcover ISBN 0-521-63057-6 $100.00). (Under review)

VI. HEAT TRANSFER

5N59. Advances in Chemical Propulsion: Science to Technology. - Edited by GD Roy *(Mech and Energy Conversion Div, Office of Naval Res, Arlington VA)*. CRC Press LLC, Boca Raton FL. 2002. 528 pp. ISBN 0-8493-1171-3.

Chemical propulsion is a complex science involving several disciplines. This book is an attempt to provide a source of reference, for a practicing engineer or a graduate student, or as a textbook for a graduate course in Advanced Topics in Combustion, as it covers some of the major issues in propulsion science and technology today in a single volume.

For current and future propulsion systems, the following three major criteria are important: 1) increase the speed and range of vehicles: Commercial and military transport and weapons; 2) obtain the maximum combustion efficiency and stable operation as possible; 3) comply with environmental constraints. These three items form the primary subject matter for this book. The topics covered range from the concept of convective Mach number to counterflow fluidic thrust vectoring; electrorheological fuels to electromagnetic propulsion; and marine propulsion to aircraft and missile propulsion. This publication is essentially an assembly of results from selected research projects that depict the advances in propulsion science made in the past several years in the context and mission of this book, particularly in air-breathing propulsion.

In addition to the Introduction and Conclusion chapters (written by the editor), the book contains 28 chapters under the following four sections: Advanced fuel synthesis and characterization; Fundamental combustion issues; Control of combustion; and Emissions and plumes.

5N60. Annual Review of Heat Transfer: Volume XII. - Edited by Chang-Lin Tien *(Univ of California, Berkeley CA)*, V Prasad *(SUNY, Stony Brook NY)*, and F Incropera *(Col of Eng, Univ of Notre Dame, Notre Dame IN)*. Begell House, New York. 2002. 381 pp. ISBN 1-56700-166-1. $108.00.

The present volume starts with a review of the advances and challenges in micro and miniaturized heat pipes, which are being used for heat dissipation in many modern communication and computing systems. The second article deals with heat transfer in low energy plasmas used for microelectronic manufacturing, while the third article reviews heat transfer and phase-change during high-power, pulsed laser ablation of metals, as in thin film deposition, micro-machining, and the synthesis of nano-materials. Processing of thermoplastic, matrix composite materials, which involves complex, multi-scale heat and mass transfer, is considered in the fourth article. The next two articles deal with heat transfer in crystal growth, a precursor for electronic and optoelectronic device fabrication. The first of these articles treats convective instabilities under various growth conditions, while the second article considers the effects of an applied magnetic field on growth phenomena, associated hydrodynamics, and the control of flow instability. The last article of this volume reviews the fundamentals of interferometric tomography and application of the technique to three-dimensional temperature measurement.

Efficient Surfaces for Heat Exchangers: Fundamentals and Design. - EK Kalinin, GA Dreitser *(Moscow Aviation Inst, Tech Univ, Moscow, Russia)*, IZ Kopp *(St-Petersburg State Tech Univ, St Petersburg, Russia)*, and AS Myakochin *(Moscow Aviation Inst, Tech Univ, Moscow, Russia)*. Begell House, New York. 2002. 392 pp. ISBN 1-56700-167-X. $85.50. (Under review)

VIII. ENERGY & ENVIRONMENT

5R61. Environmental Fluid Mechanics. - H Rubin *(Dept of Civil Eng, Technion-Israel Inst of Tech, Technion City, Haifa, 320 00, Israel)* and J Atkinson *(Dept of Civil, Struct, and Env Eng, SUNY, Buffalo NY)*. Marcel Dekker, New York. 2001. 728 pp. ISBN 0-8247-8781-1. $150.0.

Reviewed by B Sanderson (Sch of Sci and Tech, Univ of Newcastle, PO Box 127, Central Coast Campus, Quimbah, NSW, 2258, Australia).

This book has a broad scope and is written from an engineering perspective. The book is written in two parts. Part 1 covers the development of the fundamental equations and dynamical systems that focus on common simplifications to the fundamental equations. Part 2 deals with application to numerous environmental systems that are often of concern to engineers, such as: Groundwater, air-water exchanges, effluents and buoyant plumes, sediment transport, and remedial treatment of contaminated water bodies.

Scanning my bookshelves, this reviewer sees many specialized books in fluid mechanics and computational methods with titles that read like headings for chapters or subsections of Environmental Fluid Mechanics. On the other hand, environmental readers with a more biological bent will have to search elsewhere [1,2] for material relating to the fluid mechanics of organisms.

Rubin and Atkinson have written a book that would serve well as a text for several introductory courses in environmental fluid mechanics from an engineering perspective. Many worked problems are included with each chapter. Diagrams illustrate much of the text and many of the problems. Worked problems serve to beautifully illustrate and further develop material in the text. Problems are thematic and provide a contiguous learning experience for students. Unsolved problems and targeted suggestions for further reading serve as a launching point for more specialized studies.

Treatment of topics such as suspended sediment transport and groundwater flow are substantially enhanced by their integration into a broad ranging text and development within the context of fundamental mathematics and fluid mechanics. This reviewer found the treatment of groundwater more insightful than one would expect from such a brief exposition—it almost renders redundant one specialist book on my shelf. Occasionally, however, brevity leads to unbalanced treatment. For example, a reasoned exposition of vertical circulation associated with wind forced set-up in a lake is associated with an unexplained and potentially misleading diagram of horizontal circulation. Discussion of topics indicates the extent to which knowledge is derivable from basic laws, or empirical. The authors are to be congratulated for illustrating many of the topics with numerical models. Numerical methods are often rudimentary, but they are sufficient for the problems addressed and are thoughtfully used to calculate specific solutions to fluid mechanical problems.

Technically, the book is well prepared with a logical sequence for development of topics, a useful subject index, and clear figures. Minor typographical errors might cause some confusion. Viscosity, for example, is sometimes given the same symbol as the y-component of velocity and some references to equation numbers are incorrect. But these are minor issues when placed in the context of what is otherwise a lucid presentation. This reviewer recommends *Environmental Fluid Mechanics* as an appropriate text for several courses introducing topical subjects in environmental fluid mechanics. This book will prove a valuable acquisition for teachers, students, and libraries.

References

[1] Okubo A (1980), *Diffusion and Ecological Problems: Mathematical Models*. Springer Verlag.

[2] Vogel S (1981), *Life in Moving Fluids*. Princeton Univ Press.

IX. BIOENGINEERING

5N62. Measurement of Cardiac Deformations from MRI: Physical and Mathematical Models. Computational Imaging and Vision, Vol 23. - Edited by AA Amini *(Washington Univ, St Louis MO)* and JL Prince *(Johns Hopkins Univ, Baltimore MD)*. Kluwer Acad/Plenum, Bristol, UK. 2001. 344 pp. ISBN 1-4020-0222-X. $106.00.

This book describes the latest imaging and image analysis techniques that have been developed at leading centers for the visualization, analysis, and understanding of normal and abnormal cardiac motion with magnetic resonance imaging (MRI). The use of MRI in measuring cardiac motion is particularly important because MRI is non-invasive, and it is the only modality capable of imaging detailed intramural motion within the myocardium.

Biomedical engineers, medical physicists, computer scientists, and physicians interested in learning about the latest advances in cardiovascular MRI should find this book to be an educational resource. In particular, it is more tutorial in nature than most of the technical papers where the research was originally published. Practitioners and researchers working in the field of cardiovascular MRI will find the book to be filled with practical technical details and references to other work, enabling the implementation of existing methods and serving as a basis for further research in the area.

5N63. Mechanics of Inhaled Pharmaceutical Aerosols: An Introduction. - WH Finlay *(Univ of Alberta, AB, Canada)*. Academic Book Collection, Irvine CA. 2001. 306 pp. ISBN 0122569717. $79.95.

This work provides a comprehensive treatment of the mechanics of inhaled pharmaceutical aerosols. The book covers a wide range of topics, and many new perspectives are given by drawing on research from a variety of fields. Novel, in-depth expositions of the most common delivery devices are given, including nebulizers, dry powder inhalers, and propellant metered dose inhalers. The behavior of aerosols in the respiratory tract is explained in detail, with complete coverage of the fundamentals of current deposition models.

X. GENERAL & MISCELLANEOUS

5N64. Advanced Engineering Mathematics. - A Jeffrey *(Univ of Newcastle Upon Tyne, UK)*. Academic Press, Orlando. 2002. Casebound. ISBN 0-12-382592-X.

This book provides comprehensive and contemporary coverage of key mathematical ideas, methods, and their widespread applications, for students majoring in engineering, computer science, mathematics, and physics. Using a wide range of examples throughout the book, the author illustrates how to construct mathematical models, how to apply mathematical reasoning to select a particular solution from a range of possible alternatives, and how to determine which solution has physical significance. Many chapters end with computer projects that require the use of a CAS (such as Maple® or Mathematica®) to reinforce ideas and provide insight into more advanced problems.

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