

BOOK REVIEWS

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I. FOUNDATIONS & BASIC METHODS

7R1. Fundamentals of Computational Fluid Dynamics. - H Lomax (*Deceased*), TH Pulliam (*NASA Ames Res Center, Moffett Field CA 94035*), DW Zingg (*Inst for Aerospace Stud, Univ of Toronto, 4925 Dufferin St, Toronto, ON, M3H 5T6, Canada*). Springer-Verlag, Berlin. 2001. 249 pp. ISBN 3-540-41607-2. \$49.95.

Reviewed by TA Kowalewski (*Center of Mech and Info Tech, IPPT PAN, Inst of Fund Res, Polish Acad of Sci, Swietokrzyska 21, Rm 211, Warsaw, PL 00-049, Poland*).

The book provides an elementary tutorial presentation on computational methods in fluid mechanics. The authors intend this book to serve as a survey of mathematical fundamentals which provide foundation for the computational fluid dynamics. As a result of this focus, the book is suitable as a textbook for a first course in CFD. The underlying philosophy of the authors is that the theory of linear algebra provides a basic mathematical framework for understanding numerical methods. Hence, the material presented emphasizes fundamental concepts of numerical methods in which the partial differential equations are reduced to ordinary differential equations, and finally to the difference equations, ie, to the linear system of algebraic equations.

The book begins with an outline of the basic equations. The authors leading concept is to explain fundamentals of CFD on the basis of simple *model* equations, isolating physical characteristics of the complete set of equations. Therefore, after a brief introduction to the Euler and Navier-Stokes equations, the two basic models are discussed in more details: diffusion and convection equations. In the following chapter, the concept of finite-difference approximation to partial derivatives is explained. The basic issues in constructing differencing schemes for solving partial differential

equations using matrix operators are given. The Fourier error analysis is applied to estimate the accuracy of a finite-difference scheme. An extensive discussion of the difference operators at boundaries is exemplified for two selected model equations, linear convection and diffusion. The two strategies for obtaining finite-difference approximation for time dependent problems are discussed using the basic concept of the biconvection and diffusion model equations, with fundamental analysis of properties of solutions expressed in real and eigenspace.

In Chapter 5, the reader finds the basics of finite-volume approximation and the discussion on advantages of using integral form of the model equations. The next two chapters describe, in detail, the theory and implementation of time-marching discretization methods, including their stability and the accuracy analysis. Chapter 8 gives several practical hints for applying time-marching methods to the specific problem. The concept of the numerical stiffness is used to classify stability of particular discrete approximation. This chapter can be very valuable for the end users of CFD methods, helping them to select appropriate numerical approach to the physical problem studied. In principle, the first eight chapters may appear to be sufficient to explain the basic mathematics of CFD modeling. The three chapters following them form a practical handbook of different CFD approaches, describing methodology for designing, analyzing, and choosing time-marching methods. The description of properties and applications of several classical relaxation methods gives good introduction to iterative techniques accelerating solution of large systems of equations. It is followed by a very brief description of the idea of constructing multigrid computational domain. The important problem of numerical dissipation is elucidated for few typical schemes in Chapter 11. The last two chapters present and analyze split and factored algorithms.

The book is well written and well organized. It can be easily adopted as a textbook for senior or graduate students studying numerical methods of fluid mechanics. Practice exercises are provided at the end of each chapter, some of them expecting the reader to write his own computer codes. This reviewer would regard *Fundamentals of Computational Fluid Dynamics* as essential to anyone planning to use CFD modeling. The emphasis of the book is on understanding basic mathematics underlying the discretization ideology. However, this book is not a practical handbook of numerical

methods. The emphasis of the book is on the mathematical aspects of CFD with limited attention on the physics of the problems solved. Therefore, inexperienced readers may have difficulties in applying knowledge gained here to construct their own codes for solving practical problems of fluid mechanics.

7R2. Mechanical Behavior of Engineering Materials, Volume 1: Static and Quasi-Static Loading. - YM Haddad (*Dept of Mech Eng, Univ of Ottawa, Ottawa, ON, Canada*). Kluwer Acad Publ, Dordrecht, Netherlands. 2000. 426 pp. ISBN 0-7923-6355-8. \$210.00.

Reviewed by J-C Roegiers (*Rock Mech Inst, Univ of Oklahoma, Sarkeys Energy Center, Ste P119C, 100 E Boyd, Norman OK 73019-0628*).

This book can be considered as a solid reference book containing most of the concepts of static (and quasi-static) mechanics. As such, it first introduces the fundamentals of material behavior, discussing its response and providing data interpretation rules. In his "Introduction," the author sets the stage by clearly differentiating the various loading rates and their effects on the material response. He also explains why it is preferable to use tensorial calculus when studying the mechanics of deformable media. Both Cartesian as well as curvilinear tensors are introduced in Chapter 1 and Appendix A, respectively. The reader is then exposed to the next logical topics of stress and strains, fundamental concepts in Chapters 2 and 3. Basic assumptions and conventions are clearly stated; the continuum mechanics principles such as conservation and continuity are also introduced. It should be pointed out that at the end of each chapter, the author has given a number of example problems with their solutions as well as some additional exercises. In addition, he has provided recommended further reading lists. Chapter 3 also introduces the reader to kinematics via sequential configurations.

In Chapter 4, the author critically reviews the fundamental thermodynamics concepts, emphasizing the assumptions and limitations. In addition, Chapter 5 discusses the various material behaviors. Hence, the first five chapters, which constitutes more than 50% of this book, provide the proper foundation for the remainder of the chapters.

Elastic response material is dealt with first in Chapter 6 from a classical elasticity point of view, both linear as well as nonlinear. The book contains a few classical examples. Unfortunately, this chapter does not contain any example problems or exercises. Inelastic and time-dependent deformations

are introduced in Chapter 7. Both strain hardening and elasto-plastic modeling are covered in detail. At the end of the chapter, the author also discusses in some detail creep and relaxation, emphasizing the time-dependent behavior of some modern man-made materials, such as high polymers and composites. Finally, Chapter 8 covers the visco- and thermovisco-elasticity.

As already mentioned earlier, the three appendices provide the reader with some mathematical background required to be able to follow some of the complex derivations. This is rather useful as the reader is not obliged to refer to other mathematical books.

7R3. 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.

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

Random heterogeneous materials are those composed of randomly distributed phases or different material domains such as composites or materials with voids. The various domains forming the microstructure have macroscopic properties because they are larger than molecules. A major problem is to develop a rigorous method of characterizing the microstructure. Probability functions are used to describe the various microstructures, whether heterogeneous, homogeneous, isotropic, etc. A canonical n -point correlation function provides a unified means to describe arbitrary microstructures. The presentation is restricted to microstructures which are independent of time.

Several idealized models of the microstructure are presented. In a hard sphere model, the ill-defined idea of randomly closed packed spheres is replaced by the well-defined idea of a maximally random jammed configuration. The degree of penetrability and the distribution of radii of the spheres are adjusted to represent different types of microstructure. Anisotropy is modeled with ellipsoidal or cylindrical inclusions. Some hierarchical laminates have optimal transport properties. Foams or some biological materials are better modeled by the space-filling cell structures described. Percolation is modeled using the idea of clusters, a connected group of the random elements.

The Monte Carlo method is used to produce both equilibrium and non-equilibrium realizations of random media. The idea is to generate a random microstructure and then study its properties. An appendix lists a FORTRAN program to create an equilibrium configuration of uniform hard disks.

The second part of the book studies the relation of the bulk effective properties to

the microstructure of a random heterogeneous material. The probability characterizations of the microstructure given in the first part are used to compute the effective bulk properties in the four different areas of conduction, elasticity, trapping, and flow in porous media. The study is generally restricted to ergodic two-phase random media. In each case, a local linear constitutive model is assumed, as is local statistical homogeneity. The focus is on steady-state behavior. The resulting elasticity theory permits definition of linear viscoelasticity through the correspondence principle.

Processes are represented by averaged, or homogenized, partial differential equations. The averaging requires two length scales, one for the microstructure and one for the bulk material. Generally, the response is composed of a slow component due to the global scale including the applied loads and a fast component due to the microstructure. The averaging is carried out subject to conservation relations.

Variational principles are used to bound the values of the properties, which in general cannot be computed exactly. Exceptions are some periodic microstructures, the Hashin-Shtrikman isotropic dispersion of spheres, or the hierarchical laminates. Single inclusion problems are solved and used to estimate the dependence of effective properties on volume fraction and inclusion shape. Trial fields to determine bounds on the properties, using the variational principles, are developed for the four classes of example effective properties. The results of the first part of the book are used to compute the bounds in two-phase random heterogeneous materials. The book ends by examining the problem of determining one effective property from information about others.

This book is part of an Applied Mathematics series, and it primarily concerns the mathematical analysis of random structures. This work can serve as a foundation for those who wish to design random heterogeneous structures with specified bulk properties. A major contribution of the book is to clearly and rigorously explain the statistical characterization of the microstructure of these materials as a foundation for an analysis of effective properties. This theory, at least to the extent developed in this book, only produces linear models for the bulk properties of solids; nonlinear behavior is not covered.

The intended interdisciplinary audience is graduate students and researchers in fields such as applied mathematics, physics, chemistry, materials science, engineering, geology, and biology. The suggested prerequisites are the basics of probability, statistical mechanics, advanced calculus, and continuum mechanics. The author's stated attempt to avoid technical jargon is largely successful. An extensive reference list is provided. *Random Heterogeneous Materials: Microstructure and Macroscopic Prop-*

erties should become a standard reference for those beginning a study of random heterogeneous media.

7N4. Multi-Dimensional Complex Variable Boundary Element Method. Topics in Engineering Series, Vol 40. - T Hromadka (*Integral Consultants*). WIT Press, Southampton, UK. 2002. 243 pp. ISBN 1-85312-908-9. \$137.00.

The Complex Variable Boundary Element Method (CVBEM) is a numerical technique useful in developing approximations of boundary value problems involving the Laplace and Poisson partial differential equations. Because the CVBEM is based upon the Cauchy integral theorem of complex variables, it has so far been limited to 2D geometry applications. In this book, the geometry barrier is removed as the author extends the CVBEM to solving 3D problems.

The text features a detailed overview of the CVBEM, as well as details of its development into three- and higher-dimensional geometries. A computer program listing and several application problems are also included.

7N5. Transformation of Domain Effects to the Boundary. Advances in Boundary Elements Series, Vol 14. - Edited by YF Rashed (*Wessex Inst of Tech, Southampton, UK*). WIT Press, Southampton, UK. 2002. 330 pp. ISBN 1-85312-896-1. \$167.00.

Describing methods for the transformation of the domain integrals to the boundary, this book includes both analytical and numerical techniques. The analytical methods featured include particular solutions, Green Integrals and the Multiple Reciprocity Method, while the numerical techniques reviewed include developments in the Dual Reciprocity Method, advanced type of basis functions, and others. Applications covered range from anisotropic materials and plates to piezoelectric problems.

7N6. Underlying Principles of the Boundary Element Method. - D Cartwright (*Bucknell Univ*). WIT Press, Southampton, UK. 2001. 296 pp. ISBN 1-85312-839-2. \$149.00.

Providing a unified introduction to the underlying ideas of the Boundary Element Method (BEM), this book places emphasis on the principles of the method rather than its numerical implementation. Mathematics, when used, is explained in context while mathematical details that might otherwise obscure the text are contained in appendices. The author includes many worked examples to reinforce understanding while, to aid practice, trial problems are also given in each chapter. Another feature is the algorithmic approach to the derivation of the governing equations which enables readers new to the BEM to make more rapid progress.

Adaptive Meshing with Boundary Elements. Topics in Engineering, Vol 41. - JC Miranda-Valenzuela (*ITESM Campus Toluca, Mexico*) and KH Muci-Kuchler (*Univ of Detroit Mercy, Detroit MI 48219*). WIT Press, Southampton, UK. 2002. 293 pp. ISBN 1-85312-888-0. \$169.00. (Under review)

Boundary Element Programming in Mechanics. - Xiao-Wei Gao (*Dept of Mech and Aerospace Eng, Arizona State Univ, Tempe AZ*) and TG Davies (*Glasgow Univ, UK*). Cambridge UP, Cambridge, UK. 2002. 254 pp. (CD-Rom included). ISBN 0-521-77359-8. \$69.95. (Under review)

Computational Fluid Dynamics. - TJ Chung (*Dept of Mech and Aerospace Eng, Univ of Alabama, Huntsville AL*). Cambridge UP, Cambridge, UK. 2002. 1012 pp. ISBN 0-521-59416-2. \$95.00. (Under review)

Mechanical and Thermodynamical Modeling of Fluid Interfaces. Advances in Mathematics for Applied Sciences Series, Vol 58. -

parameter. He finds several basic structural conditions aiming at the existence of a well-behaved limit as the parameter tends to zero. Also, he demonstrates a first general theorem on the existence of a traveling wave solution. Zumbrun presents a comprehensive treatment of shock stability for systems including both multidimensional and regularizing effects based on the Evans function technique. No simple summary of this article is adequate for the amount of materials presented in it. The main contribution, by his own word, is to reduce the study of viscous shock stability to the study of generalized spectrum conditions: the first a purely ODE problem and the second, mainly linear algebraic. The latter, augmented with a viscous condition, is verified as a necessary condition for stability, and furnishes a myriad of examples of both multi- and one-dimensional viscous instability through the literature on inviscid shock dynamics. The former allows the numerical detection of Poincaré-Hopf or other interesting bifurcations not captured by inviscid analysis.

The article by Smoller and Temple on classes of shock wave solutions to the Einstein equations is exciting and provocative. The characterization by the editors that it constitutes a whole new area of research is not far from the truth. They looked at the question that many of us pondered about, but did not (or could not) do anything about it: that is, could the big bang be a shock wave? If so, what are the mathematical and physical conditions that allow such an interpretation? It is provocative, because it offers alternative views of the standard model for cosmology—that there is a shock wave present at the leading edge of the universe. It is speculative in that it assumes a state outside the shock wave (that is, outside the edge of the universe) and that “the space-time before the explosion occurred took a long time getting into the pre-explosion configuration.” Plus, because of irreversibility in the shock, “it becomes impossible to reconstruct the details of the early explosion from present data, at least at the level of the continuum model.”

Because of the “expansive” article by Smoller and Temple, the book, *Advances in the Theory of Shock Waves*, is recommended not only for the specialists in the mathematical theory of shock waves, but also those in cosmology as well as anyone whose thinking extends to the leading edge of the universe.

7R9. 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.

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

The author has documented in this text his many works and accomplishments in this

important area of flow induced vibration. This book has many positive features that make it worthy of consideration for practicing engineers in the power industry. The author has 33 years of experience, and the text is a credit to his understanding of the theory and analysis of self-excited instabilities of structures in liquid flow fields. Many of the concepts he has developed can be extended to and be useful for design of vertical pumps, vibrating pump impellers, canned motors, and all other submerged structures.

The book consists of 14 chapters; each chapter has a summary introduction and nomenclature section followed by a more in-depth treatment of the various subjects. The double use of some variables and others missing from the nomenclature makes it more challenging to assure the proper interpretation of the equations. The first chapter will be discussed at the end of this review. Au-Yang presents a good discussion of kinematics, vibrations, and acoustics in Chapter 2 and structural dynamics in Chapter 3. The information is presented nicely and with workable equations understood by engineers having a second course in vibrations or modal analysis. The author tried to reduce the mathematics in the text and give only useable equations. However, many practicing engineers may not routinely apply Bessel functions in simple solutions, but it seems necessary to master the subjects of added hydraulic mass and damping covered in Chapter 4. Chapter 5 was to simplify this, but the simple equations have terms that were not defined, and the example uses yet other terminology. The discussion of vortex-induced vibration in Chapter 6 contains good discussion and examples. Chapter 7 presents the critical velocity for fluid-elastic instability of tube bundles which move back to higher math to present the theory. The next two chapters cover turbulence-induced vibration in parallel and cross-flow conditions. Chapter 10 discusses axial flow-induced vibration with some workable equations and then presents a very nice discussion of leakage flow-induced vibration in pipes and valves. The next chapter discusses impact, fatigue, and wear of tubes and includes what appears to be simple equations and fatigue curves for estimating potential concern for impact wear of vibrating tubes. Acoustically induced vibration and noise is covered in Chapter 12 with workable equations, good discussion, and six case studies. The final chapter discusses signal analysis and diagnostic techniques. A brief discussion of ultrasonic, eddy-current, and Hall effect transducers plus motor current signature analysis concludes the text.

The previous comments have covered very briefly and in most part, the content of Chapters 2–13. This leaves only Chapter 1 for further comment. At first glance, the material presented was thought to be exactly what would be needed by a practicing engineer in any US-based industry. The dis-

cussion of both SI and US units is, in fact, necessary and required. What is needed in this chapter is a correct discussion of the conversion constant required for both SI and US units. Proper physical units are lost in calculations if the conversion constant and units are not included. The author presents what could be a workable procedure, but there is an error on page four where an electronic form of ASME steam tables (1979) is quoted to give dynamic viscosity in units of lbf/sq.ft/second. This is obviously wrong, but on page 5 the table has units of dynamic viscosity wrong in both US and SI system of units. Then on page 93, the units of dynamic viscosity appear correct, but the kinematic viscosity units are now reported in error. Finally on page 130, the units for both are correct. While the author indicated he was not going to use lb_m , many examples are quoting what must be in fact lb_m . Many engineers in US industries still use lb_m correctly. Proper application of English Engineering, English Gravitational, or US units and conversion constants will help prevent such errors.

The influence of liquids on vibrating structures is an area of research needing even more coverage and documentation than what is included in this text. Overall, it is very valuable that Au-Yang has documented his vast experience in this book, *Flow-Induced Vibration of Power and Process Plant Components: A Practical Workbook*. The insight and discussions, including in particular the examples and case studies, are reason enough to purchase this book.

7R10. Nonlinear Hyperbolic Waves in Multi-Dimensions. Monographs and Surveys in Pure and Applied Mathematics, Vol 121. - P Prasad (*Dept of Math, Indian Inst of Sci, Bangalore, India*). Chapman and Hall/CRC, Boca Raton FL. 2001. 338 pp. ISBN 1-58488-072-4. \$89.95.

Reviewed by Shi Tsan Wu (Dept of Mech and Aerospace Eng, Univ of Alabama, Sparkman Dr, Huntsville AL 35899).

In this book, the authors have discussed the propagation of a curved nonlinear wavefront for the ordinary fluid dynamics (ie without considering magneto-fluids) according to two fundamental physical processes: *i*) at different points of the wavefront, it travels with different speeds depending on the local amplitude leading to a longitudinal stretching of rays; and *ii*) a lateral deviation of rays is produced due to non-uniform distribution of the amplitude of the wave front.

This book consists of ten chapters. The first three chapters introduce all necessary mathematical concepts and some basic results. For example, the fundamentals of nonlinear hyperbolic waves are given in Chapter 1. In Chapter 2, the basic results of hyperbolic systems are presented. These results include *i*) discussion of hyperbolic system of first order equations in two inde-

the authors fail to include examples of a much broader scope and modern interest. Such systems occur in gear transmissions due to the unavoidable backlash of gears. The study of impact in these systems is of current research interest, with books devoted to their study, eg, that by Pfeiffer and Glocker (1996). These systems show, in some instances, a chaotic behavior, which is a recognized source of noise in automotive transmissions. Other instances where impact loading leads to serious performance deterioration is found in mechatronic systems, where frequent velocity reversals make backlash a source of discontinuous perturbations. Moreover, systems with discontinuous characteristics have been studied for some time, within a system-theoretic context, eg, (Flügge-Lotz, 1968), but the authors appear too focused on the Russian literature to cite the rich literature in English on the topic.

The authors focus on methods developed by themselves, apparently, in the seventies. In fact, the book is admittedly the English translation of an original book in Russian, but the authors do not disclose the bibliographical information of that original. Most likely, the original book was published in the early eighties. The methods favored by the authors are of the paper-and-pencil type—some would say “analytic,” but this qualifier is, in this reviewer’s opinion, a misnomer—and hence, limited to models that are crude approximations of actual systems. These methods are of academic interest, but it is dangerous to overstate their relevance in light of contemporary tools for simulation, such as Matlab’s Simulink Toolbox. The book would have a more permanent value if it had taken into account modern software and hardware for scientific computations. Not a word is said of algorithms for simulation, which have been developed first and foremost to cope with nonlinear systems, whether with weakly or with strongly nonlinear features. In this vein, it is worth citing Strang (1988): “Solving a problem no longer means writing down an infinite series or finding a formula like Cramer’s rule, but constructing an effective algorithm.”

In coping with the periodic response of systems, the authors hint to an algorithm for solving the integral Fredholm equation thus resulting. However, they mislead the reader into believing that the solution of the underlying system of N linear equations in N unknowns, “may be solved using the [sic] Cramer’s rule.” In fact, Cramer’s rule is inapplicable in practice, by virtue of the combinatoric nature of the number of floating-point operations it requires. This number, roughly $(N+1)!$, becomes prohibitively large for even moderate values of N , like $N=25$.

Technical issues apart, the layout of the book is unusual, to say the least. For starters, the book is divided into three chapters and 10 sections, with a continuous section

numbering across chapters. Moreover, while the equation display is highly acceptable—an unusual feature for books typeset in *Word*—some pages lack right justification, which makes the layout look weird. The bibliography is admittedly limited to the essential references. However, there is a discontinuity here, for the bibliography, made up of 204 references, is limited and outdated—the former because, with counted exceptions, the bibliography includes only Russian works; the latter because the most recent entry is of 1983. To compensate this, the book includes an “Additional Bibliography,” of 40 additional entries, with some works published outside of Russia. These references appear to be listed without citation, although this feature is difficult to verify, mainly because the reference list follows an awkward ordering: the first reference cited is entry [49], followed by [56], and so on. If a numbering of references is to be followed, then each reference should be numbered in order of citation!

The figures, in turn, appear without a caption, and composed figures, with parts referred to as A), B), etc, sometimes lack their appropriate label.

Otherwise, the English is not standard. For example, what is known as the “impulse response” of a linear system, is referred to as the system “Green function.” This is not technically wrong, but looks unfamiliar, especially because Green functions, in the English literature, usually pertain to the solutions of boundary-value problems in a space domain, more so than to solutions of initial-value problems in the time domain. Then, what is known in English as “rational functions” are labeled in the book as “meromorphic functions.” A search of the term in Maple, for example, under “topic,” led to a bulky number of entries, none of which bears the “meromorphic” qualifier. A few such entries bear the name “rational,” however. It would have been convenient to have the English translation proofread by a specialist with knowledge of the usual terminology in English.

All in all, it is difficult to recommend this monograph as a valuable reference of contemporary relevance.

7R13. Virtual Testing of Mechanical Systems: Theories and Techniques. Advances in Engineering, Vol 4. - OI Sivertsen (*Norwegian Univ of Sci and Tech, Trondheim, Norway*). Swets and Zeitlinger Publ, Lisse, Netherlands. 2001. 189 pp. ISBN 90-265-1811-0. \$87.00.

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

Andrianov 6005.doc

This textbook is intended for users of the multidisciplinary simulation code FEDEM (see also <http://www.fedem.com>). Parts of text have been used for some years in a course for first-year graduate students. Knowledge of finite element procedure is

needed for understanding of the method presented.

In Chapter 1, the author introduces some definitions and proposes some examples of industrial simulation. Chapter 2 offers a short description of used concepts from matrix algebra, vector calculus, geometric transformations, finite element procedure, Gauss’s elimination method, and eigenvalue problem. Chapter 3 deals with the structural and kinematic modeling aspects of mechanisms, joint and link coordinate systems, super elements, joints, stiffness, masses, transmissions, dampers, and forces.

In Chapter 4, concepts of numerical simulations are presented. It contains descriptions of dynamic simulation, control in mechanism simulation, simulations results, and energy calculations. In Chapter 5, the author describes general ideas of how described algorithms may be used as a design tool. The text in the appendices describes co-rotational geometric stiffness and the cam joint.

Virtual Testing of Mechanical Systems: Theories and Techniques is clearly written and meets the expectations of this reviewer. The figures are clearly drawn and the book has a nice appearance. Although there is no subject index, this reviewer thinks the book will be useful for readers. The book is probably too specialized to justify broad acquisition by libraries, but it is certainly recommended for FEDEM users as introductory course.

7N14. Advances in Dynamics and Impact Mechanics. Impact and Damage on Structures, Vol 1. - Edited by G Nurick (*Univ of Cape Town, S Africa*) and CA Brebbia (*Wessex Inst of Tech, Southampton, UK*). WIT Press, Southampton, UK. 2002. 325 pp. ISBN 1-85312-928-3. \$165.00.

This book contains invited chapters by international researchers in dynamics and impact mechanics. It covers a wide range of topics including both experimental and theoretical studies. Many comparisons between computer results and experimental measurements are presented. Readers will find up-to-date information on many different aspects and applications of impact mechanics.

7N15. 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. 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 multi-body systems with nonlinear deformations are finding their way into the commercial general-purpose software in both finite elements and multibody dynamics packages, providing powerful 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 reaches its full potential. This book, which is an outgrowth of a NATO Advanced Research Workshop that

brought together the 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.

7N16. Crashworthiness of Composites and Light Weight Structures. Proc of ASME Congress, Nov 2001, New York. - Edited by G Newaz, N Saha, O Faruque. ASME, New York. 2001. 112 pp. ISBN 0-7918-3579-0. ASME Book No I00547. \$70.00. (ASME members \$35.00).

The 14 papers in this collection cover recent advances in materials and structures technology and computational advances. Papers reflect the general goals of advances in materials technologies, modeling, and computational and complex vehicle crash dynamics simulations.

7N17. Flow-Induced Vibration in Engineering Practice. Advances in Fluid Mechanics Series, Vol 31. - Edited by P Anagnostopoulos (Aristotle Univ, Thessaloniki, Greece). WIT Press, Southampton, UK. 2002. 250 pp. ISBN 1-85312-644-6. \$127.00.

Collecting together and refining material previously scattered throughout specialized journals, this text presents various aspects of flow-induced vibration. It provides a unique source of information for graduate students, researchers, and practicing engineers.

Contents cover vibrations induced by vortex shedding; mathematical models for vortex-induced vibrations of beams; fluidelastic instabilities of cylinder arrays in cross-flow (an investigation of the use of Connor's equation); galloping of slender bodies; and dynamics of rotor flow coupled systems.

7N18. Structures Under Shock and Impact VII. Proc from 7th Int Conf. - Edited by N Jones (Dept of Mech Eng, Univ of Liverpool, Brownlow Hill, Liverpool, L69 3BX, UK), CA Brebbia (Wessex Inst of Tech, Southampton, UK), AM Rajendran (US Army Research Lab). WIT Press, Southampton, UK. 2002. 550 pp. ISBN 1-85312-911-9. \$277.00.

Papers featured in this book examine the interaction between blast pressure and surface or underground substructures, whether the blast is from civilian, military, dust explosions, vapor cloud detonation, or other sources. Topics covered include protection of structures from blast loads; surface structures under explosive shock; buried structures under explosions; missile penetration and explosion; collision forces on structures; demolition of structures; localized explosions on structures; full and model-scale testing; interaction between analytical and experimental research; formulation of design recommendations; structural crashworthiness and new software for shock and impact; energy absorbing systems; seismic engineering applications; material response to high rate loading; behavior of concrete structural components; and behavior on steel and composite structures.

7N19. Vibration and Control of Mechanical Systems—2001. Proc of ASME Congress, Nov 2001, New York. - Edited by HR Hamidzadeh, H Rahnejat, ACJ Luo. ASME, New York. 2001. 400 pp. ISBN 0-7918-3548-0. ASME Book No I00516. \$150.00. (ASME members \$75.00).

Fifty-one full-length, peer-reviewed technical papers in this proceedings provide an exchange of new ideas, concepts, and technologies in vibration and control and focus on a wide spectrum of topics for linear and nonlinear vibration and control; flow-induced vibrations; stability, bifurcation, and chaos; vibration in manufacturing processing and MEMS; and vibration in biomechanics.

Classical Many-Body Problems Amenable to Exact Treatments: (Solvable and/or Integrable and/or Linearizable...) in One-, Two-, and Three-Dimensional Space. Lecture Notes

in Physics, Vol m66. - F Calogero (Dept of Phys, Univ of Rome "La Sapienza," p Aldo Moro, Rome, 00185, Italy). Springer-Verlag, Berlin. 2001. 749 pp. ISBN 3-540-41764-8. \$79.95. (Under review)

Dynamics of Evolutionary Equations. Applied Math Sciences, Vol 143. - GR Sell (Sch of Math, Univ of Minnesota, Minneapolis MN 55455) and Yuncheng You (Dept of Math, Univ of S Florida, Tampa FL 33620-5700). Springer-Verlag, New York. 2002. 670 pp. ISBN 0-387-98347-3. \$79.00. (Under review)

Dynamics with Friction: Modeling, Analysis and Experiment, Part II. Stability, Vibration, and Control of Systems, Series B, Vol 7. - Edited by A Guran (Inst for Structonics, Canada), F Pfeiffer (Inst of Mech, Tech Univ, Munich, Germany), K Popp (Inst of Mech, Univ of Hannover, Germany). World Sci Publ, Singapore. 2001. 313 pp. ISBN 981-02-2954-2. \$77.00. (Under review)

Engineering Analysis in Applied Mechanics. - JW Brewer (Univ of California, Davis CA). Taylor & Francis Publ, New York NY. 2002. 472 pp. ISBN 1-56032-932-7. \$75.00. (Under review)

Generating Families in the Restricted Three-Body Problem, II: Quantitative Study of Bifurcations. Lecture Notes in Physics, Vol m65. - M Henon (CNRS, Observatoire de la Cote d'Azur, BP 4229, Nice, 06304 Cedex 4, France). Springer-Verlag, Berlin. 2001. 301 pp. ISBN 3-540-41733-8. \$44.00. (Under review)

Mechanical Behaviour of Engineering Materials, Volume 2: Dynamic Loading and Intelligent Material Systems. - YM Haddad (Mech Eng, Univ of Ottawa, Canada). Kluwer Acad Publ, Dordrecht, Netherlands. 2000. 484 pp. ISBN 0-7923-6355-8. \$225.00. (Under review)

III. AUTOMATIC & CONTROL

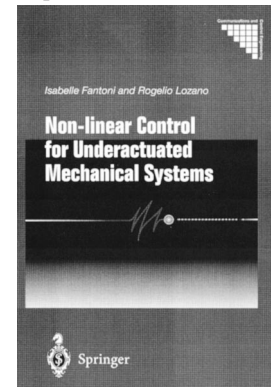
7R20. Non-linear Control for Underactuated Mechanical Systems. - I Fantoni and R Lozano (UMR CNRS 6599, Univ de Technologie de Compiègne, BP 20529, Compiègne, 60205, France). Springer-Verlag London Ltd, Surrey, UK. 2002. 295 pp. ISBN 1-85233-423-1. \$109.00.

Reviewed by SC Sinha (Dept of Mech Eng, Auburn Univ, 202 Ross Hall, Auburn AL 36849-5341).

This is an application-oriented book that is intended for engineers, graduate students, and researchers who are interested in the design of nonlinear controllers for underactuated mechanical systems. Underactuated systems are defined as systems with lesser number of independent control actuators than the degrees of freedom to be controlled. Readers with a background in intermediate level dynamics and control should have no trouble following the material.

After an introduction in Chapter 1, some definitions and background material are presented in Chapter 2. These include Lyapunov stability concepts, Krasovskii-LaSalle invariance principle, passivity criteria, and controllability condition. The next nine chapters deal with the development of control algorithms for a number of underac-

tuated mechanical systems, most of which have served as academic benchmarks. In Chapter 1, an energy-based nonlinear controller is developed for the classical problem of cart-inverted pendulum. Simulations and experimental results are also included. Similar analysis is presented in Chapter 4 that deals with a convey-crane system. Using the passivity property, an energy-based control law is proposed for a pendubot system in Chapter 5.



In Chapter 6, modeling, analysis, and control of the Furuta pendulum (named after K Furuta of Tokyo Institute of Technology) is discussed. The reaction wheel pendulum is presented in Chapter 7. Chapters 8 and 9 are devoted to the design of control algorithms for planar robots. In Chapter 8, the authors present analysis and control of two as well as three link planar robots with flexible joints while in Chapter 9, the problem of a planar robot with two prismatic and one revolute (PPR) joints is considered. It is to be observed that the PPR system has four degrees of freedom and only three control inputs. The control strategy, once again, is based on an energy approach and passivity properties of the system. The ball-beam control is described in Chapter 10, and in this case, the control force is assumed to be acting on the ball rather than the beam. The controller for a simple hovercraft model is designed in Chapter 11.

Chapter 12 deals with the control problem associated with a planar vertical take-off and landing (PVTOL) aircraft. A Lyapunov function using the forwarding technique is used to obtain the control law. The last three chapters are devoted to the modeling and control of helicopters. In Chapter 13, after some general considerations, a simplified model called the helicopter-platform model is analyzed. This model has three degrees of freedom with two control inputs. The nonlinear control strategy guarantees an asymptotic tracking of the desired trajectories. A Lagrangian formulation of the helicopter dynamics is presented in Chapter 14 and a Lyapunov approach is used to design a tracking controller. The same problem is discussed in Chapter 15 via the Newtonian approach. In this case, the control algorithm was developed using the backstepping and Lyapunov techniques.

In summary, *Non-linear Control for Un-*

deractuated Mechanical Systems is an excellent source for the development of control strategies for an important class of problems, viz, the underactuated mechanical systems. The book is clearly written, and the ideas are conveyed well by the authors. This book is a must for engineering graduate students, researchers, teachers, as well as practicing engineers. It is strongly recommended for individuals and libraries.

7R21. Practical Methods for Optimal Control using Nonlinear Programming. - JT Betts (*Res and Tech Div, Boeing Co, Seattle WA*). SIAM, Philadelphia. 2001. 190 pp. ISBN 0-89871-488-5. \$51.00.

Reviewed by I Kolmanovsky (Sci Res Lab, MD-2036, Ford Motor Co, 2101 Village Rd, Dearborn MI 48124).

System models are routinely developed in engineering and other disciplines for system analysis and simulation. They now find widespread use in industry in all phases of design and development of technological systems. Model-based trajectory optimization and optimal control are among key tools that facilitate finding better ways to operate and control complex engineering systems. They are also becoming essential in the design phase, to determine system parameters which meet stringent performance objectives and constraints.

In this regard, this book is quite timely. Its detailed treatment of methods and strategies used to solve such optimal control and trajectory optimization problems (complete with in-depth discussion of implementation, tricks, and "what can go wrong" issues) will be useful to optimization practitioners and insightful to researchers focused on various aspects of optimization. The focus of the book is a family of techniques (often referred to as direct methods) wherein the optimal control problem is converted into a finite-dimensional optimization problem using method of transcription. The finite-dimensional problem can be solved using nonlinear programming techniques. The basic idea of transcription is to treat the values of the state and control variables at discrete-time instants as free variables to which constrained, nonlinear programming optimization can then be applied. The constraints are inherited from the original optimal control problem formulation and are also induced by the discretization/integration of the differential equations governing the system dynamics. Efficient computational strategies can be developed if the nonlinear programming algorithm used in the second stage takes advantage of the structure of the problem (sparsity), which is induced as a result of integrating the dynamics equations in the first phase.

The book is very readable. In part, it is due to its theorem-free format while relying instead on a detailed discussion and illustration of how to setup numerical methods and strategies to solve optimal control problems, what can happen, and what can go

wrong. Enough detail is given so that the reader also gets a good flavor of the nature of rigorous theoretical results (found in the references provided in the book).

The book is organized as follows. The first chapter reviews the main ideas and techniques of nonlinear programming, including unconstrained minimization methods (Newton and quasi-Newton methods) and constrained optimization techniques (such as Sequential Quadratic Programming or SQP). The review is concise and self-contained, providing the reader quick access to the main ideas used in high-performance optimization codes. Practical issues of what can go wrong such as infeasible constraints, discontinuous objective functions, rank-deficient constraints, and constraint redundancy are illustrated with specific examples. Practical remedies to handle these difficulties are discussed. Chapter 2 discusses large scale nonlinear programming problems and, in particular, the case when the Hessian matrix and Jacobian matrix are sparse, that is most of their elements are zero. In this situation, sparse finite differences can be used to approximate first and second derivatives in a computationally efficient fashion. This and the resulting sparse SQP algorithm are described in detail. Chapter 3 reviews several classical numerical methods for solving initial and boundary value problems for ordinary differential equations. It is the central idea of the book that numerical methods for solving (integrating or discretizing) ODEs give rise to nonlinear programming problems which are sparse, and the sparsity properties depend on a particular method used for discretization. Thus after the transcription, it is possible to take advantage of a particular sparse structure (induced by a particular discretization method) in solving the nonlinear programming problem. This is basically the subject of Chapter 4. What can go wrong is discussed including how to recognize the emergence of singular arcs and discontinuous control, as well as consideration of the issues involved in problems with state constraints. Strategies to switch from lower order ODE integration routines (used at the beginning) to higher order routines as well as mesh refinement strategies are detailed. Chapter 5 reports several of the numerical case studies that the author successfully solved in the past using the techniques described in the book. They are examples of realistic trajectory optimization problems, primarily drawn from the aerospace field. They are, respectively: Space shuttle reentry trajectory optimization, minimum time to climb for an aeroplane, low-thrust orbit transfer for a spacecraft, and two burn orbit transfer for a spacecraft, as well as trajectory optimization for an industrial robot and a multibody mechanism. These case studies provide a good illustration of the techniques de-

scribed in the book and describe additional strategies to deal with particular issues and problem formulations.

On a critical side, the book only covers one particular class of techniques for solving optimal control problems. Methods based on dynamic programming (which provide optimal control policy in a feedback form) and methods based on calculated gradients through the solution of adjoint equations are not covered. The latter are discussed, with an argument that the adjoint equation approach may not often be applied to the complex models anyway since they may not admit a readily available symbolic representation adequate for the development of linearized equations. The techniques described in the book are implemented in software called SOCS, commercially available from Boeing. This software is briefly described in the Appendix. A limited version of this software (trial version) or other computational codes for the reader to experiment with would amplify the appeal of this book, but are presently not available.

In summary, *Practical Methods for Optimal Control using Nonlinear Programming* will be useful and is recommended to researchers and engineers in industry and academia whose projects involve solving optimal control/trajectory optimization problems. The book can also be used, as a supplemental text, in graduate-level university courses on optimal control and numerical methods in optimal control. It should also be possible to develop a special topics graduate-level course based on the material in this book, supplemented with theoretical details from the reference literature.

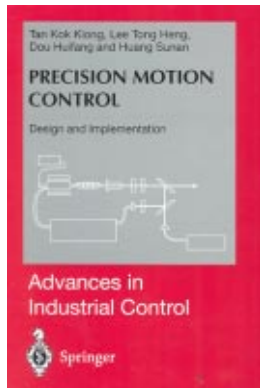
7R22. Precision Motion Control: Design and Implementation. - Tan Kok Kiong, Lee Tong Heng, Dou Huifang, Huang Sunan (*Dept of Elec Eng, Natl Univ, 4 Engineering Dr 3, Singapore, 117576, Singapore*). Springer-Verlag London Ltd, Surrey, UK. 2001. 232 pp. ISBN 1-85233-328-6. \$89.95.

Reviewed by PH Meckl (Sch of Mech Eng, Purdue Univ, 1288 Mech Eng Bldg, W Lafayette IN 47907-1288).

As both mechanical and electronic components decrease in size, the need for precision manufacturing continues to grow. The authors of this book have skillfully brought together a variety of essential ingredients for success in achieving precision motion control. Their objective is to focus on "enabling technologies in the realization of precision motion positioning systems." The book presents concepts in "a manner amenable to a broad base of readers, ranging from the academics to the practitioners, by providing detailed experimental verifications of the developed materials." The book serves as a useful reference for anyone interested in applying the latest technologies to precision motion control.

The authors set the stage by describing a

variety of processes in precision manufacturing, including nanofabrication techniques such as lithography, ultra-precision machining, and laser micromachining. They also briefly describe precision metrology devices, including the Scanning Tunneling Microscope (STM) and the Atomic Force Microscope (AFM).



After this short introduction, the book focuses on the development of motion control techniques for precision tracking. The primary actuator considered during controller development is the permanent magnet linear motor (PMLM). Its dynamic model includes the standard electrical and mechanical properties as well as force ripple and nonlinear friction effects as described by the so-called Tustin model. A composite motion control scheme is proposed, which includes feedforward compensation, proportional-integral-derivative (PID) feedback, and nonlinear compensation using Radial Basis Functions. Acceleration feedback is suggested to improve tracking, and a disturbance observer is developed to cancel unknown load disturbances. For more challenging control applications, the book proposes a robust adaptive controller using sliding modes and parameter adaptation to compensate for friction and ripple effects. A feedforward iterative learning controller is also developed for those applications that are repetitive. For each control development, the authors present stability proofs as well as experimental results to demonstrate the effectiveness of each technique.

Since performance of the PID feedback controller depends heavily on the validity of the parameters used in its development, the authors devote an entire chapter to auto-tuning techniques for determining model parameters. They propose a novel two-channel relay auto-tuning technique that is based on a describing function analysis. This approach uses a second parallel relay signal with an integrator so that the relay auto-tuning approach can be applied to servo-mechanical systems that typically do not have the time delays found in chemical process control systems.

Another chapter is devoted to coordinated motion control of several axes. After describing classical master-slave and set-point coordinated control, they propose a fully coordinated control approach that includes

inter-axis offsets deduced from a disturbance observer. Again, a complete set of experimental results is provided to compare the effectiveness of each of these approaches.

Another crucial ingredient in any precision motion control scheme is precise measurement of position. A laser measurement system, which uses a linear interferometer and retro-reflector, is described in detail. Then the principles behind geometric error calculation are presented. Measurements from the laser system are compared to those obtained from optical linear encoders, and linear, angular, straightness, and squareness errors are computed. Finally, several approaches to geometric error compensation are described, including look-up tables and a nonlinear parametric approximation that uses Radial Basis Functions. The authors also provide a clever technique to remove bias errors when averaging several measurements that are corrupted by random errors. Since electronic interpolation is required to extract sufficient resolution out of optical encoders, another chapter provides details of several approaches to reduce interpolation errors.

The last important topic for achieving precision motion control is vibration attenuation. The authors focus on external vibration sources and propose two approaches to reduce errors caused by vibrations. One approach uses an adaptive digital notch filter "to identify the resonant frequencies and to subsequently terminate any signal transmission at these frequencies." The second approach uses an accelerometer mounted on the machine to monitor vibration levels, analyzes their frequency content, and determines when these vibrations exceed the threshold of acceptable performance.

Since all of these control algorithms are implemented in software, another chapter is devoted to details of the dSPACE control platform, which includes automatic code generation using MATLAB Simulink, hardware-in-the-loop testing capability, and a virtual instrument panel as user interface.

Unfortunately, the book does not mention the concept of input shaping for vibration control. In many cases, the motions themselves can cause detrimental vibrations that cannot be tolerated by precision machines. Input shaping modifies the motor commands so that these vibrations are greatly reduced.

However, besides that minor omission, *Precision Motion Control: Design and Implementation* nicely integrates a number of important topics in precision motion control. It also comes with a complete set of references for further information. All told, it represents a useful reference and an excellent single source of essential topics related to precision motion control.

7N23. Electromagnetic Nondestructive Evaluation, V. Studies in Applied Electromag-

netics and Mechanics, Vol 21. - Edited by J Pavo, G Vertesy, T Takagi, 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. 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.

7N24. Proceedings of the ASME Dynamic Systems and Control Division—2001. Proc of ASME Congress, Nov 2001, New York. - Edited by M Franchek. ASME, New York. 2001. 1124 pp. ISBN 0-7918-3560-X. ASME Book No I00528. \$330.00. (ASME members \$165.00).

There are 139 full-length, peer-reviewed technical papers in this volume covering intelligent sensors; advanced automotive technologies; automated modeling; active noise control; electrohydraulics; adaptive and optimal control; nonlinear modeling and control of manufacturing processes and systems; intelligent systems; distributed control systems; adaptive tuned vibration absorbers; structural vibration control; system identification; hybrid systems and control; modeling, control, and diagnostics of large-scaled systems; and advances in robot dynamics and control.

Control Theory for Linear Systems. - HL Trentelman (*Dept of Math, Univ of Groningen, PO Box 800, Groningen, 9700 AV, Netherlands*), AA Stoorvogel, M Hautus (*Dept of Math and Comput Sci, Eindhoven Univ of Tech, PO Box 513, Eindhoven, 5600 MB, Netherlands*). Springer-Verlag London Ltd, Surrey, UK. 2001. 389 pp. ISBN 1-85233-316-2. \$84.95. (Under review)

Functional Adaptive Control: An Intelligent Systems Approach. - SG Fabri (*Dept of Elec Power and Control Eng, Univ of Malta, Msida, MSD 06, Malta*) and V Kadirkamanathan (*Dept of Autom Control and Syst Eng, Univ of Sheffield, Sheffield, S1 3JD, UK*). Springer-Verlag London Ltd, Surrey, UK. 2001. 266 pp. ISBN 1-85233-438-X. \$99.00. (Under review)

MEMS Handbook. - Edited by M Gad-el-Hak (*Dept of Aerospace and Mech Eng, Univ of Notre Dame, Notre Dame IN 46556*). CRC Press LLC, Boca Raton FL. 2002. 1368 pp. ISBN 0-8493-0077-0. \$149.95. (Under review)

IV. MECHANICS OF SOLIDS

7R25. Digital Photoelasticity: Advanced Techniques and Applications. - K Ramesh (*Dept of Mech Eng, Indian Inst of Tech, Kanpur, 208016, India*). Springer-Verlag, Berlin. 2000. 410 pp. CD-ROM included. ISBN 3-540-66795-4. \$116.00.

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

Experimental methods of stress analysis continue to hold their own in spite of the appeal of analytical solutions, which are seen to be elegant and challenging in some

cases; and numerical methods, which are considered convenient and inexpensive given the abundance of user-friendly, commercially-available software and powerful, fast personal computers today. Photoelasticity is, arguably, the most favored in the pantheon of the experimental techniques. However, no revolutionary developments have occurred in the methods used for photoelastic studies for a very long time (The latest is, perhaps, the PhotoStress® photoelastic coating method, introduced in 1956.) During this same period, great strides have been made in the field of digital image processing. It was inevitable, therefore, that some intersection of these two fields would occur. Digital photoelasticity—a product of this cross-fertilization—has been the subject of a number of journal articles, but very few books. Perhaps many considered writing a book at this stage in the development of the subject rather daunting. The author of the book under review is to be applauded for being brave enough to take on this task. The result is a textbook containing 11 chapters, in which the basic principles of the various strands of the subject are explained in detail, and the salient features of various applications illustrating the use of these principles are presented.

In Chapter 1 (*Transmission photoelasticity*), all the rudiments and fundamental concepts of photoelasticity are described in a succinct fashion. Thus, myriad topics are covered, these being: the nature of light, polarization, the passage of light through isotropic and crystalline media, light ellipse, retardation and wave plates, the stress-optic law, the arrangements of optical elements in a plane polariscope and a circular polariscope, determination of isoclinic and isochromatic fringe order at a point, compensation techniques, calibration of photoelastic model materials, fringe ordering, determination of the sign of the boundary stresses, methods of resolving the ambiguity on the principal stress direction, the key features of three-dimensional photoelasticity and integrated photoelasticity, and model-to-prototype relations.

In Chapter 2 (*Reflection photoelasticity*), the focus is this technique which is a variant of transmission photoelasticity and is useful for stress analysis of opaque prototypes. The chapter begins with a clear description of the basic principle of the technique, comparing and contrasting it with the more well-known transmission photoelasticity. This is followed by an abbreviated account of the development of photoelastic coatings from their first use by Mesnager in 1930 to the derivation, by Zandman *et al* in 1962, of correction factors for interpreting fringe patterns. Following this, various aspects of the technique are described, with the topics covered including the optical arrangement of a reflection polariscope, stress- and strain-optic relations for a photoelastic coating, correction

factors for photoelastic coatings, the Poisson's ratio mismatch problem, the desirable properties of a photoelastic coating, considerations in selection of the coating thickness, collection of the basic data (fringe order and isoclinic parameter) and methods of analyzing them, and examples of application of photoelastic coatings.

The concepts covered in Chapter 3 (*Digital image processing*) are those that are needed for understanding the role of digital image processing in photoelasticity. The chapter opens with a presentation of a number of basic ideas, such as image sampling and quantization, and then a wide array of relevant concepts are covered in more detail, among which are characteristics of video standards in use today, image sensors, a number of basic relationships and mathematical operations between pixels (such as neighbors of a pixel and arithmetic operations), the basic steps in image processing, the elements of a typical image processing system, the structure and design of software, various tools for image understanding (such as pseudo coloring and three-dimensional intensity plots), and techniques for image enhancement and segmentation (such as histogram equalization and dynamic thresholding).

The material presented in Chapter 4 (*Fringe multiplication, fringe thinning, and fringe clustering*) could be divided into three parts. In the first, there are descriptions of digital techniques to effect these operations. Among the topics covered are image subtraction of bright and dark-field images and half-fringe photoelasticity. In the second part, algorithms developed for use in conjunction with the intensity-based methods of fringe processing are presented, among which are masked-based algorithms for skeleton extraction and the row-wise scanning algorithm for fringe skeletonization. In the third part of the chapter, the issues covered include applications of the algorithms, improvements to global thinning algorithms, and evaluation of the performance of various fringe thinning algorithms.

In Chapter 5 (*Phase shifting, polarization stepping, and Fourier transform methods*), copious details of these techniques are presented. The chapter begins with a summary of the early attempts to automate polariscopes, highlighting the contributions of people such as Zandman, Sapaly, Allison, Nurse, Redner, and Marston. Following this, the basic principles of phase shifting are described followed by expositions on a wide range of topics, such as the generic arrangement of plane and circular polariscopes, whole field evaluation of photoelastic data using these polariscopes, sources of error and methods of minimizing their impact on the results obtained. In the middle part of the chapter, there is a short description of polarization stepping for isoclinic determination, a method that was introduced by Brown and Sullivan in 1990.

Three Fourier transform methods for photoelastic data acquisition—use of carrier fringes, multiple polarization stepped images, and load stepping—are described in the later sections of the chapter. The chapter ends with comments on the relative attractions and drawbacks of the three groups of techniques covered.

All the topics treated in Chapter 6 (*Phase unwrapping and optically enhanced tiling in digital photoelasticity*) are related to improving the quality of the data collected. Among them are boundary detection, removal of binary noise at discrete points in a phase map, algorithms for phase unwrapping, parameters that affect phase unwrapping, digital magnification of high fringe density zones, cementing of an optically magnified tile with the original image, and optically enhanced tiling applied to a circular disc and ring subjected to diametral compression loading.

Spectral content analysis and the techniques that need color image processing hardware are the subject of Chapter 7 (*Colour image processing techniques*.) The first part of the chapter contains a short description of the main features of the two main color models used for the image processing: the red-blue-green (RGB) and the hue-saturation-intensity (HSI) models. The second part of the chapter deals with color image processing systems, the spectral response of a color camera, the light intensity transmitted in white light for various polariscope arrangements, principles, calibration, and an application of three fringe photoelasticity, and phase shifting in color domain. The third part is dedicated to spectral content analysis and the tricolor photoelastic method.

Chapter 8 (*Evaluation of contact stress and fracture parameters*) deals with the use of digital photoelasticity for the determination of these characteristics, which are known to play influential roles in the service performance of a wide assortment of mechanical components and systems. Among the topics covered are the basic data required and their digital acquisition, the stress analysis for two cylindrical bodies in contact, evaluation of contact stress parameters by least squares analysis, the stress field equations in the vicinity of a crack tip, evaluation of mixed-mode stress field parameters using least squares analysis, and experimental validation of the stress field parameters for Mode I and Mixed-Mode loadings. The uses of a number of the principles described are illustrated with respect to an application problem, that of a spur gear, for which the values of a large number of parameters—such as fracture toughness and the constant stress term, contact length and friction coefficient—were obtained and are presented.

Considered in Chapter 9 (*Stress separation techniques*) are the auxiliary methods used to obtain the individual values of the

principal stresses or, in a more complete sense, the values of all the elements of the stress tensor. The chapter opens with a brief survey of experimental methods (the oblique incidence method, the conventional shear difference technique, and the Tesar shear difference technique), numerical methods (finite difference method, stress-difference elasticity concept, and the least squares method), and hybrid methods. Following this survey, various details (such as finite element formulation and discretization of the domain) are provided about a relatively new approach in which phase shifting and the finite element analysis method are combined. Also, descriptions of the application of the approach to an example problem—that of a finite plate, containing a hole, in uniaxial tension—are given. The chapter ends with discussions on the use of integrated photoelasticity concepts for stress separation, stress separation in 3D photoelasticity, and stress separation in reflection photoelasticity.

In Chapter 10 (*Fusion of digital photoelasticity, rapid prototyping, and rapid tolling technologies*), the interconnectedness between these three state-of-the-art methods is explored. Thus, among the topics covered are the application of rapid prototyping processes for fabricating models to be used in photoelastic studies, illustration of this application using photoelastic models made using fused deposition modeling and then coated with a photoelastic coating, and digital photoelastic characterization of a model fabricated using a rapid tooling process.

The subjects of Chapter 11 (*Recent developments and future trends*) are newly emergent concepts and research ideas at various stages of maturity. Among the recent developments discussed are the methods for determining the characteristic parameters for a given length of the light path, namely the axis of the retarder, the retardation introduced by the retarder, and the rotary power of the rotator; tensorial tomography; new digital image processing hardware, such as improved frame grabbers, progressive scan cameras, and time-delay-and-integration (TDI) sensors; new digital image processing software, such as the Matrox Imaging Library and the FRN_DAT package; digital dynamic photoelasticity, using charge-coupled-devices and TDI cameras; and the use of photoelasticity for the stress analysis of components and structures fabricated from filamentary composite materials. Among the future trends identified are the potential for using *Windows*-based software for, for example, fringe unwrapping; use of applets; development of device-independent software; and the use of wavelet transforms for isochromatic fringe ordering.

The book has many attractive features, some of which have to do with substance and others with style. In the former category, the following features may be cited:

meticulous use of Jones calculus to set up the governing equations (where applicable) and the various optical arrangements; a comprehensive treatment of the relevant concepts in each chapter; incorporation of recent developments in other fields into photoelastic evaluation, such as direct analysis of parts fabricated using fused deposition modeling; inclusion of a long list of references, most of which were very recent, at the end of each chapter; and a writing style that is consistently perspicacious. As for aesthetics, the material in the book is arranged in an orderly manner, and there are copious supporting materials (211 figures and 39 tables), including clear and sharp fringes in the reproduced photoelastic images.

The book has two shortcomings. First, many of the exercises given at the end of each chapter are not of the requisite standard for the intended readership of senior-level undergraduate and graduate students. (There are too many descriptive questions.) Second, the book does not contain lists of acronyms and symbols. Inclusion of these lists would have facilitated reading in cases where the symbol or acronym is not defined in the page being read.

The author has produced a first-class textbook that should find widespread use among students, researchers, and design engineers in many branches of engineering. The present reviewer thus recommends *Digital Photoelasticity: Advanced Techniques and Applications* with the warmest enthusiasm.

7R26. Fracture Mechanics of Metals, Composites, Welds, and Bolted Joints: Application of LEFM, EPFM, and FMDM Theory. - B Farahmand. Kluwer Acad Publ, Dordrecht, Netherlands. 2001. 408 pp. ISBN 0-7923-7239-5. \$140.00.

Reviewed by MH Aliabadi (Dept of Comput Mech, Queen Mary and Westfield Col, Univ of London, Mile Eng, London, E1 4NS, UK).

AA Griffith carried out the first systematic investigation of fracture phenomena, 82 years ago. Since that investigation, the subject of fracture mechanics has matured and formed an essential part of the structural integrity assessment of engineering structures. The concepts of safe-life and damage tolerant design in nuclear, pressure vessel, and aerospace industries are of paramount importance. This book is a welcome addition to a growing number of books on the subject. Parts of the text can be used for undergraduate teaching, but the book as a whole is aimed at the graduate level with emphasis on the applications rather than theoretical developments of the subject.

The book is divided into eight chapters. The first presents an overview of fracture mechanics and failure prevention. Here basic parameters in Linear Elastic Fracture Mechanics (LEFM) and Elastoplastic Fracture Mechanics (EPFM) are presented. Also

discussed are topics such as Failure Prevention and Fracture Control and Non Destructive Inspection. The second chapter is entitled Linear Elastic Fracture Mechanics and Applications. Here, the fundamental concepts are reviewed and essential fracture parameters such as stress intensity factor are described. Also presented are residual strength diagrams and practical concepts such as leak-before burst. Chapter 3 concentrates on fatigue crack growth and applications. In this chapter, the crack closure concept as presented by Elber is presented. Also presented are Wheeler and Willenborg retardation models. Other topics covered include environmental assisted corrosion cracking.

**FRACTURE MECHANICS
OF METALS,
COMPOSITES, WELDS,
AND BOLTED JOINTS**

Application of LEFM, EPFM,
and FMDM Theory

Bahram Farahmand, Ph.D.
Boeing Technical Fellow

Kluwer Academic Publishers

The next two chapters deal with nonlinear concepts. Elastic-plastic fracture mechanics is covered in Chapter 4. Here, the concepts such as nonlinear J-integral are presented without going through the mathematical derivations. Several applications are presented to demonstrate the use of the EPFM. Chapter 5 deals with the fracture mechanics of ductile metals.

The next three chapters are aimed at practical applications. Chapter 6 presents welded joints and applications. Topics such as friction stir welding are examined. Applications to Bolted Joints are subject of the next chapter. The final chapter deals with an important topic, Damage Tolerance of Composites. This chapter is co-authored by A Abdi, L Minnetyan, and C Chamis. Here different failure modes of composite materials are described. Particular emphasis is given to a computer code GENO-PFA.

Fracture Mechanics of Metals, Composites, Welds, and Bolted Joints is well written and includes many interesting examples. The text is complementary to most other texts on the subject, as emphasis throughout the book is on applications rather than the mathematical theoretical developments.

7R27. Metal Failures: Mechanisms, Analysis, Prevention. - AJ McEvily (*Dept of Metall and Mat Eng, Univ of Connecticut CT*). Wiley, New York. 2002. 336 pp. ISBN 0-471-41436-0. \$90.00.

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

The failure of metal components in ser-

vice is obviously a complex subject that requires thorough understanding of loading conditions, material microstructures, operating environments, and inspection technologies. The author has done an admirable job of providing the necessary background information for understanding and analyzing metal failures. The most fascinating aspect of this book is the presentation of numerous case studies that the author uses to illustrate failure mechanisms and techniques for analysis. The prevention of metal failures is addressed primarily through the conclusions reached in the case studies.

This book is intended for use in one-semester courses for senior engineering students or graduate engineers. Within mechanical engineering departments, portions of the book would definitely be useful in upper-level, core design courses. The book could be used in its entirety for a mechanical engineering, undergraduate technical elective course. Since significant portions of the book are materials science oriented, this book is also very relevant to senior capstone courses within materials science curricula. In addition, engineers involved in accident investigation and expert witness consulting would find this book useful because of its breadth and reference to relevant literature.

The book begins with 11 descriptions of structures and vehicles that failed in service due to loads and design (eg, the 1981 Kansas City Hyatt Regency Walkways Collapse), inspection, maintenance, and repair (eg, the 1988 Aloha Airlines Boeing 737-200 Accident), and other problems (eg the 2000 Air France Concorde Crash). Subsequent chapters provide theoretical background necessary to analyze stresses (Chapter 2, Elements of Elastic and Plastic Design; Chapter 3, Elements of Fracture Mechanics), microstructure and processing (Chapter 4, Alloys and Coatings; Chapter 6, Brittle and Ductile Fractures; Chapter 11, Defects), and loadings and environment (Chapter 7, Thermal and Residual Stresses; Chapter 9, Creep Failure; Chapter 10, Fatigue; Chapter 12, Environmental Effects). Interspersed are chapters on Examination and Reporting Procedures (Chapter 5), Statistical Distributions (Chapter 6), Flaw Detection (Chapter 13), and Cranes Hooks, Coil Springs, Roller Bearings, Bushings, and Gears (Chapter 14). Although whole textbooks have been written on the subject matter of most of these chapters, the author has provided enough detail to enable meaningful analysis without overwhelming the reader. The reader who is interested in more detail can refer to the references.

Nearly all chapters have interwoven case studies that illustrate issues being discussed in the chapter. The higher profile case studies have quality photographs and illustrations that help the reader understand the investigation. For the most part, these case studies provided excellent connections between theory and practice. Future editions

could attempt to further connect the case studies to the theoretical development through reference to the relevant equations and through worked examples. At the end of the book, the author has provided 3–4 problems for each chapter.

The book is well written with very good figures and a thorough index. The author's presentation of case studies of accidents leaves the reader with a clear understanding of what went wrong. Accidents that are not the result of operator error can usually be traced back to mistakes with respect to design, construction, materials, inspection, loadings, and environment. Through reading *Metal Failures: Mechanisms, Analysis, Prevention*, engineers are given the tools necessary to understand, analyze, and hopefully prevent metal failures.

7R28. Thin Plates and Shells: Theory, Analysis, and Applications. - E Ventsel (*Eng Sci and Mech Dept, Penn State, Univ Park PA 16802*) and T Krauthammer (*Protective Tech Center, Penn State, Univ Park PA 16802*). Marcel Dekker, New York, 2001. 666 pp. ISBN 0-8247-0575-0. \$175.00.

Reviewed by E Carrera (Dept of Aerospace Eng, Politecnico di Torino, Corso Duca Degli Abruzzi 24, Torino, 10129, Italy).

"Thin plates," "thin shells," and "thin plates and shells" are classical subjects for books. Eminent scientists, such as Vlasov, Flügge, Novozhilov, Timoshenko, Washizu, Kraus, Gold'sveizer, Cicala, Librescu, Donnell, Vekua, and Leissa among others, have written milestone books on the topic. All of these books are, with no doubt, excellent sources for the analysis of two-dimensional structures. Most of these classical books have appeared in the middle of the last century and, in the same case each book states the point of view of each scientist on plate and shell theories. A few books on plates and shells are known which have been published in the recent past. Among these the book by Ventsel and Krauthammer is one of the most useful and exhaustive. It includes both plate and shell geometries as well as theories and solutions of practical problems. Ventsel and Krauthammer present several topics in a manner which results in a brilliant selection of different possible ways to see plates and shells as they are known by the classical books mentioned above. This book is a good synthesis of West and East Schools of knowledge on plates and shells. It is clearly written, self complete, and rich with examples as well as of applications to practical problems. The authors have shown their own ability in writing a book on plates and shells avoiding vectorial or tensorial notations which could introduce difficulties to beginners. The editorial form is quite well done: figures, plots, formulas, and texts are very well balanced in each chapter and on each page.

The book has been divided in two parts which deal with thin plates and thin shells, respectively. Each part quotes introduction, fundamentals, membrane and bending response, buckling, and vibrations. A brief description of the book's layout is given below.

Part I is first considered. Chapter 1 offers a very interesting historical note on plates theories. Fundamentals of elasticity relations are recalled in a Cartesian reference system. Kirchhoff's thin plate theory has been described in Chapter 2; governing equations are derived by using both elasticity relations and variational statements. Bending of rectangular plates are treated in Chapter 3; a large variety of practical problems have been solved by considering different geometries, boundary conditions and applied loadings. Chapter 4 has been devoted to circular plates. Polar coordinates have been preferred in this case. Other geometries, such as elliptical and triangular plates have been solved in Chapter 5. Approximated solution methods and their applications are discussed in Chapter 6 in which Finite Difference, Finite Element, and Boundary Element Methods are introduced and applied to two-dimensional flat structures. Advanced topics are addressed in Chapter 7; thermoelastic problems, stiffened plates, orthotropic behavior, refined theories accounting for transverse shear deformation effects, geometrically nonlinear behavior, layered, and sandwich plates are considered. Buckling of plates has been considered in Chapter 8; introductory concepts are first introduced, buckling of rectangular and circular plates are then solved by application of equilibrium and energy methods. Results are also given for stiffened, orthotropic, and sandwich plates. Large deflection and post-buckling response have also been treated in this chapter. Dynamic problems are considered in Chapter 9.

Thin shells theory and analysis begin with Chapter 10. This chapter introduces shell structure and makes an historical note on main shell theory contributions and developments. Concepts related to differential geometry of surfaces are given in Chapter 11. First and second fundamental forms are derived and particularized to several geometrical shell configurations (shell of revolution, cylindrical, and conical). Linear elasticity relations in curvilinear coordinates and in the framework of Kirchhoff-Love postulates are presented in Chapter 12. Membrane shell theories and applications are considered in Chapters 13 and 14, respectively. Methods, solution techniques, and results are presented for a large variety of problems, such as roof shell structures, liquid storage facilities, and pressurized vessels. So called moment theory has been addressed in Chapter 15 for circular cylindrical cases. The asymptotic integration method has been used to solve the differential equations of cylindrical shell subjected

to general loadings. Solutions of particular cases are presented in the same chapter. Extension to shells of revolution is given in Chapter 16. Other well known approximated shell theories are discussed and applied in Chapter 17. The advanced topic already discussed in Chapter 8 for the plate cases, are extended to shells in Chapter 18. In addition, Chapter 18 gives details of the application of Newton's Method to solve nonlinear problems. Buckling and vibration problems of shells are discussed in Chapters 19 and 20, respectively. Five Appendices close the book. The first one quotes useful data while the others detail some derivations which were not explicitly given in the previous chapters.

This reviewer's opinion is *Thin Plates and Shells: Theory, Analysis, and Applications* by Ventsel and Krauthammer contains those basics and advanced arguments that should be known to any engineer or scientist who is supposed to work with plate and shell structures.

7R29. Three-Dimensional Contact Problems. Solid Mechanics and its Applications, Vol 93. - VM Alexandrov (*Dept of Mech and Math, Moscow State Univ, Moscow, Russia*) and DA Pozharskii (*Mech and Appl Math Inst, Rostov-on-Don State Univ, Rostov-on-Don, Russia*). Kluwer Acad Publ, Dordrecht, Netherlands. 2001. 406 pp. ISBN 0-7923-7165-8. \$131.00.

Reviewed by JT Tielking (PO Box 1009, Daleville VA 24083-1009).

The calculation of stress and displacement in elastic bodies loaded by contact with one another or against a rigid surface is a difficult problem in applied mechanics. Even for linear material and infinitesimal displacements, the problem is nonlinear when the boundary of the contact region is unknown a priori. This book presents the derivation of analytic solutions for a variety of problems involving isotropic linearly-elastic bodies in frictionless, static contact. Separate chapters are devoted to contact problems for cylinders, wedges, cones, and spheres. Numerical results for spherical problems are compared with Hertz solutions to show the ranges of validity of the Hertz analysis.

The exact calculation of pressure in the contact interface requires solution of an integral equation, a system of integral equations in the case of 3D problems. For certain punch problems, and others of engineering interest, the contact boundary is specified so that the governing equations are linear. Various transformations are used to extract solutions in terms of special functions or in asymptotic expansions. The important problem of determining the contact boundary, as well as the normal contact pressure, is formulated as a nonlinear boundary integral equation of the Hammerstein type. This formulation is due to B A Galanov who also developed an algorithm based on Newton's method for solving this

type of nonlinear integral equation. A Fortran listing of Galanov's computer program is given in the Appendix. Numerical results from the program are compared in the text with results from analytic solutions for two test problems.

The large collection of analytic solutions presented in this book will be useful in evaluating test results calculated by boundary element and finite element methods. The book is well-written by the authors (a translator is not listed). Good drawings are included to define problem geometry and coordinate systems. The analyses are presented in considerable detail, and the work of others is carefully referenced, often including the page numbers where relevant equations will be found. The collected reference list covers eight pages. Many are by Russian authors, some not yet translated. There is a good index. *Three-Dimensional Contact Problems* is recommended for purchase by engineering libraries and for individuals interested in the mathematical analysis of contact problems.

7N30. CAM Design and Manufacturing Handbook. - RL Norton (*Worcester Polytechnic Inst, Worcester MA*). Indust Press, New York. 2002. 610 pp. CD-Rom included. ISBN 0-8311-3122-5.

This handbook brings together up-to-date cam design technology, correct design and manufacturing procedures, and recent cam research results in one volume. Beginning at an introductory level and progressing to more advanced topics, this handbook provides the information needed to properly design, model, analyze, specify, and manufacture cam-follower systems.

This book is accompanied by a 90-day trial demonstration copy of the Professional Version of DYNACAM for Windows V. 7.0. Written by the author, this program solves the equations described in the book and allows—in its fully licensed version—the design, dynamic modeling, analysis, and output of follower center, cam surface, and cutter coordinate data for any cam. It also defines conjugate cams for any application. Also included are 90-day trial demonstration copies of programs Fourbar, Sixbar, and Slider for the design of cam-follower linkages.

7N31. Compliant Structures in Nature and Engineering. - Edited by CHM Jenkins (*S Dakota Sch of Mines and Tech, Rapid City SD*). WIT Press, Southampton, UK. 2002. 400 pp. ISBN 1-85312-941-0. \$199.00.

Biological organisms are exceptionally efficient structures, having evolved over millions of years to achieve high load carrying capacity per unit weight. Compliance (flexibility) plays a significant role in the efficacy of natural structures. Examples range from cell walls and micro-organisms, to bat wings, to human muscles. Long ago, engineers adopted compliant structures for solutions where structural efficiency was critical while in modern times, compliance has seen increasing use in civil structures such as temporary storage facilities and large-span roofs.

This volume provides a summary of the important features of these interesting structures. Written by experts in the field, it covers topics on compliant structures in nature, compliant materials, mechanics of compliant structures, applications in engineering, and design for compliance. The text will contribute to our continued learning from nature in order to design highly efficient engineering structures.

7N32. Contemporary Research in Engineering Mechanics: Symposium in Honor of Professor George J Simites. Proc of ASME Con-

gress, Nov 2001, New York. - Edited by GA Kardomateas and V Birman. ASME, New York. 2001. 368 pp. ISBN 0-7918-3573-1. ASME Book No I00541. \$150.00. (ASME members \$75.00).

This collection of 28 full-length, peer-reviewed papers is dedicated to Prof George J Simites on his 70th birthday. The subjects of these papers are diverse and cover a broad spectrum of problems in engineering mechanics. The list of subjects includes buckling and structural vibrations; piezoelectric and composite/sandwich materials; numerical and analytical methods; and industrial applications. The diversity of the papers presented in this symposium reflects on the broad recognition of the achievements and the scientific reputation of Prof Simites.

7N33. Damage Initiation and Prediction in Composites, Sandwich Structures, and Thermal Barrier Coatings. Proc of ASME Congress, Nov 2001, New York. - Edited by AM Waas and JD Whitcomb. ASME, New York. 2001. 276 pp. ISBN 0-7918-3575-8. ASME Book No I00543. \$130.00. (ASME members \$65.00).

This volume is a collection of 34 full-length, peer-reviewed technical papers related to the following topics: damage initiation and prediction in composites, sandwich structures and materials, and thermal barrier coatings.

7N34. High Performance Structures and Composites. Proc of 1st of Int Conf. - Edited by CA Brebbia (*Wessex Inst of Tech, Southampton, UK*) and WP de Wilde (*Vrije Univ Brussels, Belgium*). WIT Press, Southampton, UK. 2002. 600 pp. ISBN 1-85312-904-6. \$307.00.

This volume focuses on the application of computational methods to the modeling, control, and management of such structures and materials. Particular emphasis is placed on intelligent smart structures.

Specific areas covered include general topics; high performance structures; and composites.

7N35. Macro and Microscopic Approach to Fracture. Advances in Damage Mechanics Series, Vol 3. - Edited by SI Nishida (*Saga Univ, Japan*). WIT Press, Southampton, UK. 2002. 480 pp. ISBN 1-85312-902-X. \$238.00.

Many recent reports have described instances where structures have failed under quite low loads. When such a failure occurs, it is necessary to clarify the cause, taking both a macro and microscopic approach, and to implement appropriate countermeasures. Designed to enhance the knowledge and appreciation of engineering integrity and its relevance to economic and strategic issues, this book includes chapters by internationally recognized specialists and covers a wide range of topics associated with the macro and microscopic approach to fracture.

7N36. Mechanics of Electromagnetic Material Systems and Structures. Proc of 14th US Natl Congress of Theoretical and Appl Mech. - Edited by Y Shindo (*Tohoku Univ, Japan*). WIT Press, Southampton, UK. 2002. 300 pp. ISBN 1-85312-920-8. \$153.00.

Examining current knowledge and recent advances in electromagneto-mechanics as applied to the various fields of science and technology, the papers featured cover diverse topics such as piezoelectric material systems and MEMS applications, electromagneto-elasticity and superconductivity, electromagnetic fracture, and damage mechanics. Theoretical, experimental, computational studies, and industrial applications of electromagneto-mechanics of advanced material systems and structures are covered.

7N37. Modeling and Mechanics of Granular and Porous Material. - Edited by G Capriz (*Univ of Pisa, Italy*), VN Ghionna, P Giovine (*Univ of Reggio Calabria, Italy*). Birkhauser Verlag AG, Basel, Switzerland. 2001. 300 pp. ISBN 0-8176-4241-2. \$99.00.

Modeling of granular and porous materials is necessary to describe the behavior of natural materials. In this book, engineers, mathematicians, and experts in particulate material modeling focus on the most important techniques and models currently in use. The modeling process is presented as a critical tool for studying the analysis and experimentation of the micromechanics and behavior of granular and porous material.

7N38. Proceedings of the 2001 ASME Design Engineering Technical Conferences and Computers and Information in Engineering Conference—Print Version, Vol 1. From DETC 2001, Sept 2001, Pittsburgh. - ASME, New York. 2001. 1052 pp. ISBN 0-7918-3541-3. ASME Book No I00509. \$190.00. (ASME members \$95.00).

This printed compilation of 105 full-length, peer-reviewed technical papers covers the following topics: engineering information management; internet-aided design, manufacturing, and commerce; embedded and ubiquitous computing; energy systems; computers in education; computer-aided product development; virtual environments and systems; non-traditional computing; and finite element techniques and computational technologies.

7N39. Proceedings of the 2001 ASME Design Engineering Technical Conferences and Computers and Information in Engineering Conference—Print Version, Vol 2. From DETC 2001, Sept 2001, Pittsburgh. - ASME, New York. 2001. 1384 pp. ISBN 0-7918-3542-1. ASME Book No I00510. \$190.00. (ASME members \$95.00).

This is a printed compilation of 149 full-length, peer-reviewed technical papers on the following topics: virtual reality in design; decision-based design; agent-based design; finite element modeling; product families and platforms; computer-aided design systems and frameworks; geometric modeling; and rapid manufacturing.

7N40. Thermomechanical Fatigue and Fracture. - Edited by MH Aliabadi (*Queen Mary Col, Univ of London, UK*). WIT Press, Southampton, UK. 2002. 344 pp. ISBN 1-85312-549-0. \$173.00.

Thermal and mechanical fatigue leads to initiation and growth of cracks in many structures such as pressure vessels, nuclear reactors, high temperature engines, electronic packaging, and dental materials. This book brings together state-of-the-art contributions from leading researchers in the field.

7N41. Three-Dimensional Effects in Composite and Sandwich Structures. Proc of ASME Congress, Nov 2001, New York. - Edited by YDS Rajapakse. ASME, New York. 2001. 132 pp. ISBN 0-7918-3577-4. ASME Book No I00545. \$80.00. (ASME members \$40.00).

This collection of 12 papers covers recent applications of composite and composite sandwich construction in large load-bearing structures and shows a renewed interest in three-dimensional aspects of composite materials and composite sandwich structures.

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

Mechanics of Curved Composites. Solid Mechanics and its Applications, Vol 78. - SD Akbarov (*Yildiz Tech Univ, Istanbul, Turkey*) and AN Guz (*Inst of Mech, Natl Acad of Sci, Kiev, Ukraine*). Kluwer Acad Publ, Dordrecht, Netherlands. 2000. 441 pp. ISBN 0-7923-6477-5. \$190.00. (Under review)

Nonlinear Analysis of Thin-Walled Structures: Statics, Dynamics, and Stability. Mechanical Engineering Series. - JF Doyle (*Dept of Aeronaut and Astronaut, Purdue Univ, Lafay-*

ette IN 47907). Springer-Verlag, New York. 2001. 511 pp. ISBN 0-387-95216-0. \$89.95. (Under review)

Superplastic Flow: Phenomenology and Mechanics. Engineering Materials Series. - KA Padmanabhan (*Indian Inst of Tech, Kanpur, 208016, India*), RA Vasin (*Moscow State Univ, Moscow, 119899, Russia*), FU Enikeev (*Inst of Metals Superplasticity Prob, Ufa, 450081, Russia*). Springer-Verlag, Berlin. 2001. 363 pp. ISBN 3-540-67842-5. \$99.00. (Under review)

Techniques of Tomographic Isodyne Stress Analysis. Solid Mechanics and its Applications, Vol 75. - JT Pindera (*Dept of Civil Eng, Univ of Waterloo, Waterloo, ON, Canada*). Kluwer Acad Publ, Dordrecht, Netherlands. 2000. 286 pp. ISBN 0-7923-6388-4. \$134.00. (Under review)

Thermoelastic Fracture Mechanics using Boundary Elements. Topics in Engineering, Vol 39. - DN dell'Erba (*Wessex Inst of Tech, Southampton, SO40 7AA, UK*). WIT Press, Southampton, UK. 2002. 146 pp. ISBN 1-85312-849-X. \$109.00. (Under review)

Unified Plasticity for Engineering Applications. Mathematical Concepts and Methods in Science and Engineering, Vol 47. - SR Bodner (*Technion-Israel Inst of Tech, Haifa, Israel*). Kluwer Acad/Plenum, New York. 2002. 115 pp. ISBN 0-306-46744-5. \$75.00. (Under review)

V. MECHANICS OF FLUIDS

7R42. Energy Methods for Free Boundary Problems: Applications to Nonlinear PDEs and Fluid Mechanics. Progress in Nonlinear Differential Equations and Their Applications, Vol 48. - SN Antontsev (*Dept de Matematica, Univ de Beira Interior, Covilha, 6201-001, Portugal*), JI Diaz (*Dept de Matematica Aplicada, Univ Complutense, Madrid, 28040, Spain*), S Shmarev (*Dept de Matematicas, Univ de Oviedo, Oviedo, 33007, Spain*). Birkhauser Boston, Cambridge MA. 2002. 329 pp. ISBN 0-8176-4123-8. \$79.95.

Reviewed by AJ Kassab (*Dept of Mech, Mat, and Aerospace Eng, Col of Eng, Univ of Central Florida, Orlando FL 32816-2450*).

This is a research monograph reporting on collaborative research carried out by the authors over the past 15 years in the field of free boundary problem. Specifically, the authors use energy methods as the basic tool to investigate the underlying mathematical structure of the partial differential equations (PDE) governing various field problems whose solutions lead to the formation of a free boundary. Given the definition of an energy norm, the technique results in inequalities involving ordinary differential equations whose study allows determination of the existence of a free boundary and provides a theoretical framework for the study of the solutions for the PDEs of interest. This book mainly considers application of energy methods to quasi-nonlinear equations of fluid mechanics.

The first three chapters lay the formal mathematical and theoretical framework of

energy methods applied to nonlinear PDEs. The first chapter introduces energy methods to study nonlinear stationary problems giving rise to localized solutions and hence free boundaries. Second-order elliptic equations, systems of elliptic equations, and higher-order elliptic equations as well as isotropic and anisotropic diffusion problems are considered. The second chapter addresses stabilization to a stationary solution for nonlinear evolution problems. Here again, the authors progress from parabolic equations to anisotropic parabolic equations, to systems of equations of combined type and higher order parabolic equations. The third chapter addresses space and time localization of weak solutions for nonlinear degenerate parabolic equations as well as systems of these equations. Application of energy methods to various fluid mechanics problems is provided in the fourth chapter. The chapter begins with a brief review of theoretical fluid mechanics, followed by a series of applications ranging from free boundary gas dynamics problems such as free jets and collisions of co-axial jets to filtration of immiscible fluids in porous media which finds application in recovery of oil from a reservoir and to flows of non-homogeneous non-Newtonian fluids. The authors also treat a class of problems which require the simultaneous study of surface channel flow as well as underground water flow. The final two topics studied involves the drift diffusion model for free electrons that forms quasi-linear degenerate systems of PDEs and finds application in semiconductor theory and the so-called blow up regimes in the solution of coupled PDEs for heat conduction and electrostatic potential resulting from the model of heat diffusion problems in a conductor in the presence of Joule heating.

The book often follows mathematical exposition of statement of lemmas and theorems, followed by proofs and corollaries as well as relevant remarks. Each chapter terminates with a bibliographic review and a set of open problems that are essentially proposals for a program of research in topics not fully investigated in the literature or by the authors. There are some illustrations, all of which are of high quality. There are no illustrative computational results. There is an appendix which contains some basic definitions of function spaces and a brief review of elementary inequalities and imbedding theorems. There is a copious number of 300+ references which support the text and a detailed index.

The monograph is the 48th volume in a series entitled Progress in Nonlinear Differential Equations and Their Applications, edited by H Brezis of the Mathematics Department of both Rutgers University in New Jersey, and the Universite Pierre and Marie

Curie in Paris. The series is described as lying at the interface of pure and applied mathematics, and indeed this book falls into such a category. *Energy Methods for Free Boundary Problems: Applications to Non-linear PDEs and Fluid Mechanics* can serve as a reference on the subject of energy methods when they are treated as part of mathematics post-graduate courses on partial differential equations; It is recommended for acquisition by university libraries as a quality addition to their mathematics collections.

7R43. 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.

Reviewed by JH Lienhard V (*Dept of Mech Eng, MIT, Rm 3-162, Cambridge MA 02139-4307*).

During the past 100 years, a few textbooks on the fundamental aspects of fluid dynamics have stood out. Among these are the well-known books by Lamb, by Landau and Lifshitz, and by Batchelor. The last two, in particular, are noteworthy for their focus on the essential physical phenomena and the accompanying mathematical formulations, which are presented with a minimum of distracting development of minor particular cases. Yet, research in fluid dynamics has moved on since the last of these titles appeared many years ago.

Gallavotti's remarkable new book, *Foundations of Fluid Dynamics*, takes a fresh look at the essential formulation and phenomenology of fluid dynamics as reflected in the research of the 70s, 80s, and 90s. He devotes significant attention to the mathematical properties of the Navier-Stokes equations, to chaos in fluid flows, and to turbulence. In this sense, the book may be regarded as complementary to, say, the Landau and Lifshitz book, which deals only very briefly with these subjects. The theoretical development in the text is supplemented by 400 expository exercises that take up many important and classical results.

Gallavotti begins with a chapter that summarizes the primary features of the continuum equations of motion. A central aim here is to lay out tools for use in subsequent chapters (the Rayleigh model for thermally driven convection, vector decompositions of the flow field, and so on), but the exercises within the chapter sketch a range of topics, such as Stokes formula, tidal theory, and acoustic radiation.

Gallavotti turns directly to the question of algorithms for the construction of solutions to the equations of motion. Euler algorithms, spectral algorithms, and vorticity algorithms are each considered. Note that this development is not done in pursuit of numerical techniques—its aim is to determine how (or whether) solutions to the phenom-

enological (Navier-Stokes) equations can, in general, be found. It comes as no surprise, then, that the third chapter deals entirely with the existence, uniqueness, and regularity of solutions to these equations.

The spectral algorithms enable the proof of such properties *locally*, which is to say for bounded time intervals. Global results are obtainable in two-dimensions. The three-dimensional case is more difficult. Gallavotti discusses LeRay's theory in this context, eventually reaching the conclusion that existence and uniqueness are "likely."

Two chapters on chaos and incipient turbulence follow. These include a careful development of the significance of reduced order models (such as the Lorenz equations), a discussion of bifurcation theory, and coverage of various scenarios for chaos, including the Ruell-Takens scheme. Chapter 5, titled *Ordering Chaos*, considers how chaotic behavior might be quantitatively studied or measured.

Strong turbulence—that with many degrees of freedom—is considered in Chapter 6, working primarily from Kolmogorov's theory. The final chapter of the book presents original new results on the statistical properties of turbulence built upon the foundation of Ruell's principle.

Professor Gallavotti is a mathematical physicist who uses concepts from analysis freely. This should pose no barrier to most graduate students in physics and applied mathematics, but many engineering students will lack the right preparation.

The book was typeset admirably by the author in LaTeX. It is attractively bound and printed, and reasonably priced as well. Few figures are included, owing to the nature of the material. The book might well have benefited from a nomenclature list, but the only real flaw in the production is an advertisement for a Springer-Verlag website that defaces the closing page of the book (which will be on shelves for years after the website has gone the way of the 8-inch floppy disk).

Foundations of Fluid Dynamics is strongly recommended, by this reviewer, for acquisition by academic libraries and for the use of anyone with a serious interest in the mathematical foundations of fluid dynamics.

7R44. Hydrodynamics: Examples and Problems: A Textbook. -

YA Buyevich (*Deceased*), DV Alexandrov (*Dept of Math Phys, Ural State Univ, Lenin Ave 51, Ekaterinburg, 620083, Russia*), SV Zakharov (*Inst of Math and Mech, Russian Acad of Sci, Ural Branch, S Kovalevskaja St 16, Ekaterinburg, 620219 GSP-384, Russia*). Begell House, New York. 2001. 331 pp. ISBN 1-56700-159-9. \$67.50.

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

This textbook addresses several basic fluid mechanics topics with a particular em-

phasis on mathematical aspects. The book is organized into five chapters plus six appendices and a big selection of answers to problems proposed at the end of each chapter.

Chapter 1 reviews the tensor analysis discussing covariant and contravariant vector components, derivatives, and transformations. The differencing operators are then presented in their most general form with the aim of providing the reader with the tools for the derivation of the fluid mechanics equations in every coordinate system.

Chapter 2 explains, very briefly, the foundation of dimensional analysis and, as an example, applies it to the motion of the pendulum. In the successive chapter, a short description of self-similar solutions is given, starting from the combination of independent variable to reduce a partial differential equation to an ordinary differential equation. Two sections with linear and non-linear processes discuss simple examples.

Chapter 4 is mainly concerned with flows with negligible viscous effects: a half-page introduction to hydrostatics is given with the discussion of two examples. A simple derivation of the Bernoulli equation is then presented with the solution of two additional model problems. The rest of the chapter is devoted to the discussion of potential flows treated either with standard methods and by separation of variables.

The fifth and last chapter involves viscous flows, starting from exact solutions of the Navier-Stokes equations and Stokes flows (solved by various methods) up to boundary layers and laminar flows. The book closes with a long part (about half of the book) containing problem answers and six short appendices dealing with equations on particular coordinate systems, solutions of specific differential equations, and some tabulated functions.

A very limited list of references and a subject index are given. Each chapter contains several proposed problems which help the reader in applying the explained concepts. The figure quality is sufficient; only sketches and graphs are shown. Perhaps some experimental pictures or numerical simulation plots would have helped the explanation of some concepts.

This book introduces with a particular perspective some classical topics of fluid mechanics; this reviewer has found the presentation strongly biased toward mathematical aspects while physical interpretation is sometimes lacking. Some arguments, like dimensional analysis or hydrostatics, have been described too shortly while others, like ideal and viscous exact solutions, occupy almost all of the book. Classical topics like fluid dynamics forces and turbulence are completely disregarded.

The text could be used as a reference book by the experienced researchers or graduate students involved in fluid mechanics. In contrast, this reviewer would not advise the use of this book as a text for un-

dergraduates owing to the inhomogeneous treatment of the arguments, the mathematical skew of the presentation, and the absence of important topics. The purchase of the book is advised for libraries.

7R45. 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.

Reviewed by M Gad-el-Hak (Dept of Aerospace and Mech Eng, Univ of Notre Dame, Notre Dame IN 46556).

Fluid flows in or around microdevices is the subject of the present book. Microelectromechanical systems (MEMS) refer to devices that have characteristic length of less than 1 mm, but more than 1 micron that combine electrical and mechanical components, and that are fabricated using integrated circuit batch-processing technologies. Electrostatic, magnetic, pneumatic, and thermal actuators, motors, valves, ducts, gears, and tweezers of less than 100-micron size have been fabricated. These have been used as sensors for pressure, temperature, mass flow, velocity and sound, as actuators for linear and angular motions, and as simple components for complex systems such as micro-heat-engines and micro-heat-pumps. The multidisciplinary field of MEMS has witnessed explosive growth during the last decade, and the technology is progressing at a rate that far exceeds that of our understanding of the physics involved in the operation as well as the manufacturing of those minute machines. The present book attempts to bridge this gap, focusing exclusively on flow physics within microdevices. It is perhaps the first of the genre to do so.

Microdevices often involve mass, momentum, and energy transport. Modeling gas and liquid flows through MEMS may necessitate including slip, rarefaction, compressibility, intermolecular forces, electrokinetics, dielectrophoreses, and other unconventional effects. In this book, the two authors, both renowned authorities in the modeling and numerical simulation of microflows, provide a methodical approach to flow modeling for a broad variety of microdevices. The continuum-based Navier-Stokes equations—with either the traditional no-slip or slip-flow boundary conditions—work only for a limited range of Knudsen numbers above which alternative models must be sought. These include molecular dynamics (MD), Boltzmann equation, direct simulation Monte Carlo (DSMC), and other deterministic or probabilistic molecular models. The book broadly surveys available methodologies to model and compute transport phenomena within microdevices. It includes a pretty inclusive list of numerical strategies. Consid-

ering the extensive microflow research conducted by the authors, the coverage here emphasizes their own work—including previously unpublished material—although other research is covered as well. The book's preface indicates that the original draft was based largely on the doctoral thesis of the junior author.

The book contains 10 chapters: basic concepts and technologies; governing equations; shear-driven and separated flows; pressure-driven flows in the slip regime; pressure-driven flows in the transition and free-molecular regimes; thermal effects; prototype applications; electrokinetically driven liquid flows; numerical methods for continuum simulations; and numerical methods for atomistic simulations. It seems that the last two chapters would have been better placed right after the governing equations. The authors constantly refer to Chapters 9 and 10 in their Chapters 3–8. The chapter on applications of gas microflows is too terse and would perhaps have fit the flow of the book better as part of the introduction. As compared to gas flows in microdevices, much less is known about liquid microflows, and the book reflects well this state of affairs. One should add that selecting the material for a monograph when the research field is so new as well as active is never an easy task, and the present authors should be complimented for a job well done.

Among recent books that addressed the physics of microdevices, the present one—covering only one branch of that physics—is perhaps the best of the bunch. This is a graduate-level monograph which is rigorous yet readable. The book covers both theoretical and numerical approaches to microflow problems, including ones with heat transfer. The writing is lucid and focused, never winding or verbose. The text is complemented with plenty of appropriate line drawings, sketches, and photographs. The list of references at the end is comprehensive. All chapters have good prologues, but unfortunately, none has a graceful epilogue. Finishing a particular chapter, a reader may end up wondering, so what?

This reviewer was not impressed with the production job performed by Springer-Verlag. As is more likely today for obvious cost-saving reasons, it appears that the book was published from an author-supplied, camera-ready manuscript, without the benefit of a dainty copy editor or a fastidious typesetter. Numerous typographical and grammatical errors crept through the final product and blemished what could have been an outstanding book. The book title and the table of contents each contain one glaring misshape. Units are italicized when they should not be. Hyphens, en dashes, and em dashes are confused with each other. Those are all minor quibbles, but when one is looking at a masterpiece painting, a scratch or two on the frame can be an easily avoided eye sore.

Despite the few negatives, *Micro Flows: Fundamentals and Simulation* has a lot to offer and is certainly recommended as a good place to start for MEMS students interested in flow physics. Every library should acquire this book, and for personal bookshelves, the price is not too excessive, at least by today's standards.

7R46. Schlieren and Shadowgraph Techniques: Visualizing Phenomena in Transport Media. - GS Settles (*Gas Dyn Lab, Penn State Univ, 301 D Reber Bldg, Univ Park PA 16802*). Springer-Verlag, Berlin. 2001. 376 pp. ISBN 3-540-66155-7. \$89.95.

Reviewed by EE Covert (Dept of Aeronaut and Astronaut, MIT, 77 Massachusetts Ave, Rm 9-466, Cambridge MA 02139-4307).

The title defines the contents of this book. It is printed in a small type (8 point), and is 376 pages long, including seven pages of colored plates at the end of the book. It also contains 1020 cited references. To quote from the Preface, "No attempt was made to cite all of the thousands of literature references in which the subject techniques are mentioned or used." Yet this reviewer believes Professor Settles has done an outstanding job of culling pertinent material from this richness.

The chapter titles of the book are Historical Background, Basic Concepts, Toepler's Schlieren Technique, Large Field and Focusing Methods, Specialized Schlieren Techniques, Shadowgraph Techniques, Practical Issues, Setting Up Your Own Simple Schlieren and Shadowgraph System, Applications, Qualitative Evaluation, Summary and Outlook. In addition, there are three Appendices: A—Optical Fundamentals, B—The Schlieren System as a Fourier Optical Processor, and C—Suppliers of Schlieren Systems and Components.

This reviewer believes that the author has met or exceeded his goal to "...fulfill the needs of the novice for basic information, as well as those of the professional for a thorough treatment of the topic." To his credit, Settles goes to great lengths to define the origin of the term "Schlieren" and to separate Schlieren and Shadowgraph systems from other optical techniques including Kirilian photography. The historical chapter is very interesting. Who, among most of us, knew that Hooke was the father of Schlieren Systems?

As a former supersonic wind tunnel operator, this reviewer found Chapters 2 and 3 to be of top quality, indeed as are Chapters 7 and 8. Settles has written an excellent discussion of Sensitivity, Range, and Resolving Power in Chapter 3. But, he also notes that experience is an important factor in interpreting the images. The author is clearly of a practical mind recommending the use of low cost high intensity automobile headlight bulbs as light sources, and steering the new practitioner away from high cost laser light systems. However, he admits that la-

sers are a useful light source if the proper cutoff is used. The careful reader will find useful bits of information in each chapter.

Like many experts, Settles cannot resist offering his view of the future of Schlieren systems and their application. In particular, he feels multipath and high-sensitivity Schlieren and resonant refractivity are "...ill explored pathways..." He also sees growth in the use of Schlieren microscopy, both in normal and in stereo, as well as the use of Schlieren procedures as a quality control tool for transparent film and plate manufacture and for imaging for acoustics and heating and ventilating. This reviewer feels that a quantitative Schlieren is an admirable goal, but for so-called "two-dimensional flows," which are really three-dimensional approximations to a plane flow, the mathematical difficulties in tracing back the elementary contributions from the path integral are demanding, unless a very sharp focusing Schlieren system is available. In the case of axially symmetric flow, the mathematical tools are available, but involve solving an Abelian integral equation with its singular kernel.

The book has very few detectable typographical errors. The most obvious is line 12, page 286. Occasionally, the typist hits the space bar in the middle of a word, which is only an annoyance. The index is quite complete, but a space between each change in the letters of the alphabet would have been appreciated.

This reviewer recommends *Schlieren and Shadowgraph Techniques: Visualizing Phenomena in Transport Media* to anyone interested in optical systems for flow visualization, and other studies benefiting from visualization of physical phenomena of transparent media. Even in the current period of competition for resources, an engineering librarian should carefully consider the customer's needs before deciding not to add this book to the library's collection.

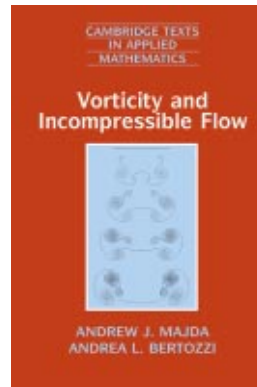
7R47. Vorticity and Incompressible Flow. Cambridge Texts in Applied Mathematics. - AJ Majda (*Courant Inst of Math Sci, New York Univ, New York NY*) and AL Bertozzi (*Duke Univ, Durham NC*). Cambridge UP, Cambridge, UK. 2002. 545 pp. Softcover. ISBN 0-521-63948-4. \$40.00. (Hardcover ISBN 0-521-63057-6 \$100.00).

Reviewed by A Ogawa (Dept of Mech Eng, Col of Eng, Nihon Univ, T 963 Tamura-machi, Kooriyama-city, Japan).

In this book, the theoretical and experimental analyses of the velocity fields with vorticity are applied to explain the physical phenomena of flow patterns of various types of vortex flows and of the flow structures in the boundary layer with high velocity gradient on a solid surface. Further, the vortex flow in nature is not always circular, but also elliptic rotational flows occur under stable and unstable conditions. Therefore, the fundamental mathematical and applied descriptions of vorticity are important fac-

tors in fluid mechanics in scientific and engineering applications. From these viewpoints, this textbook is reviewed as follows.

In Chapter 1, *Introduction to Vortex Dynamics for Incompressible Fluid Flows*, the fundamental descriptions of the Euler and the Navier-Stokes equations, and the important quantities of velocity, vorticity, helicity, impulse, and moment of fluid impulse are defined. Chapter 2, entitled *Vorticity-Stream Formulation of the Euler and the Navier-Stokes Equations*, discusses the vorticity-stream formulations of 2D. Periodic flow, cat's-eye flow, and also Beltrami flows are discussed with figures.



The existence of a solution to either the Euler or the Navier-Stokes equations on the same time interval, given generally smooth initial velocity fields, is examined in Chapter 3, *Energy Method for the Euler and the Navier-Stokes Equations*. In Chapter 4, *Particle-Trajectory Method for Existence and Uniqueness of Solution to the Euler Equation*, the questions of existence, uniqueness, and continuation of solution to the Euler and the Navier-Stokes equations are discussed. *Search for Singular Solutions to the 3D Euler Equations*, is the title for Chapter 5, where an important unsolved research problem for incompressible flow and the current attempts to make progress on this problem are the main focus. Chapter 6, *Computational Vortex Methods*, deals with computational methods for simulations of the Euler and the Navier-Stokes equations with high Reynolds number condition for vortex dynamics, and includes a brief historical summary. In order to study the motion of slender tubes of vorticity at high Reynolds numbers, Chapter 7, *Simplified Asymptotic Equations for Slender Vortex Filaments*, describes formal, but concise, asymptotic expansions to the simplified asymptotic equations; they are seen to emerge with remarkable properties. In Chapter 8, *Weak Solutions to the 2D Euler Equations with Initial Vorticity in L^∞* , a flow field having elliptic vorticity, like Thomson-Rankine combined vortex model, is examined. *Introduction to Vortex Sheets, Weak Solutions, and Approximate-Solution Sequences for the Euler Equation* is the title of Chapter 9, which describes a vortex sheet problem occurring in the vorticity layers. The last four chapters—*Weak Solutions*

and Solution Sequences in Two Dimensions, 2D Euler Equation: Concentrations and Weak Solutions with Vortex Sheet Initial Data (with an example constructed by Greengard and Thomann), *Reduced Hausdorff Dimension, Oscillations, and Measure-Valued Solutions of the Euler Equations in Two and Three Dimensions*, and *Vlasov-Poisson Equations as an Analogy to the Euler Equations for the Study of Weak Solutions* (with an analogy between vorticity and electron density)—address the mathematical theory connected with small scale structures and dynamics in high Reynolds number and inviscid flow.

To sum up, this textbook for advanced undergraduate and beginning graduate students, is aimed at mathematicians and physicists to examine mathematical theories and techniques, and to explore their applications. It appears to be a little difficult to grasp the physical phenomena involved and to apply them directly to nature and engineering. Since there is a small gap between the actual fluid flows in nature and engineering and the contents in this textbook with the examples shown, it would be better if the authors had introduced and explained the examples from W Albring, *Elementarvorgänge Fluider Wirbelbewegungen* (Akademische-Verlag, Berlin, 1981), and L Lugt, *Introduction to Vortex Theory* (Vortex Flow Press, Inc, 1996). However, for graduate students, mathematicians, and physicists who can understand the contents of the books by GK Batchelor, *An Introduction to Fluid Dynamics* (Cambridge University Press, 1999) and by LD Landau and EM Lifshitz, *Fluid Mechanics* (Butterworth-Heinemann, Oxford, 1987), this peculiar textbook certainly contributes to understanding the fundamental concepts of fluid flow with vorticity, and to apply them to nature and engineering.

7N48. Cavitation of Hydraulic Machinery. - Series on Hydraulic Machinery, Vol 1. - Edited by SC Li (*Univ of Warwick, UK*). World Sci Publ, River Edge NJ. 2001. 492 pp. ISBN 1-86094-257-1. \$125.00.

This volume deals with cavitation and its effects in turbines and pumps. After introducing cavitation and its relation with hydraulic machines, the invited contributors review in detail relevant cavitation subjects from fundamental phenomena to various problems and solution measures in hydraulic machines.

7N49. Computational Fluid Dynamics 2000. Proc of 1st Int ICCFD Conf, Kyoto, Japan, July 2000. - Edited by N Satofuka (*Syst Eng, Kyoto Inst of Tech, Kyoto, Japan*). Springer-Verlag, New York. 2001. 850 pp. ISBN 3-540-41459-2. \$159.00.

This proceedings is a compilation of papers presented at the conference.

7N50. Introduction to the Geometry and Topology of Fluid Flow. NATO Science Series II: Mathematics, Physics and Chemistry. - Edited by RL Ricca (*Math Dept, Univ College, London, UK*). Kluwer Acad Publ, Dordrecht, Netherlands. 2001. 360 pp. ISBN 1-4020-0206-8. \$129.00. (Softcover ISBN 1-4020-0207-6, \$51.00).

Leading experts present an introduction to the study of the geometry and topology of fluid flows. From basic motions on curves and sur-

faces to the recent developments in knots and links, the reader is gradually led to explore the fascinating world of geometric and topological fluid mechanics.

Geodesics and chaotic orbits, magnetic knots and vortex links, and continual flows are explained with the use of more than 160 figures and examples.

7N51. Numerical Flow Simulation II. - Edited by EH Hirschel (*Zorneding, Germany*). Springer-Verlag, New York. 2001. 345 pp. ISBN 3-540-41608-0. \$179.00.

This volume contains the CNRS-DFG Collaborative Research Program Results for 1998-2000.

Building Aerodynamics. - T Lawson (*Univ of Bristol*). Imperial Col Press, London. Distributed in USA by World Sci Publ, River Edge NJ. 2001. 286 pp. ISBN 1-86094-187-7. \$66.00. (Under review)

Introduction to Magneto hydrodynamics. Cambridge Text in Applied Mathematics. - PA Davidson (*Univ of Cambridge, UK*). Cambridge UP, Cambridge, UK. 2001. 431 pp. (Softcover). ISBN 0-521-79487-0. \$110.00. (Under review)

Large Eddy Simulation for Incompressible Flows: An Introduction. Scientific Computation Series. - P Sagaut (*DSNA/ETRI, ONERA, 29 av Div Leclerc, Châtillon, 92320, France*). Springer-Verlag, New York. 2001. 319 pp. ISBN 3-540-67890-5. \$59.95. (Under review)

Modeling in Materials Processing. - JA Dantzig and CL Tucker III (*Dept of Mech and Indust Eng, Univ of Illinois Urbana-Champaign, IL*). Cambridge UP, New York. 2001. 363 pp. Softcover (Hardcover ISBN: 0-521-77063-7, \$130.00). ISBN 0-521-77923-5. \$47.95. (Under review)

Nonlinear Flow using Dual Reciprocity. Topics in Engineering, Vol 38. - WF Florez (*Pontifical Bolivariana Univ, Colombia*). WIT Press, Southampton, UK. 2001. 132 pp. ISBN 1-85312-860-0. \$97.00. (Under review)

VI. HEAT TRANSFER

7R52. Advanced Thermodynamics Engineering. Computational Mechanics and Applied Analysis Series. - K Annamalai (*Dept of Mech Eng, Texas A&M, College Station TX 77843*) and IK Puri (*Dept of Mech Eng, Univ of Illinois, Chicago IL*). CRC Press LLC, Boca Raton FL. 2002. 786 pp. ISBN 0-8493-2553-5. \$89.95.

Reviewed by L Byrd (*ARFL/ASM, WPAFB, 2790 D St, Dayton OH 45433-7402*).

This book is best suited as a textbook for students that have had two semesters of thermodynamics. Many of the topics can also be found in introductory texts, but will be somewhat lightly studied in a standard two-class series. There are a large number of topics that are not covered in the standard mechanical engineering sequence, although they come up in combustion or the chemical engineers sequence. One advantage of this book is that the material is in one text, and so it can act as a reference for practicing engineers. An extensive nomenclature list is included which is fortunate because the authors tend to use a lot of symbols and acronyms. It also makes it

easier to read just the section of interest rather than starting at the beginning and reading material that is irrelevant to define the variables. A quick outline of the book reveals:

- Multi-component, multi-phase thermodynamics,
- An introduction to statistical thermodynamics,
- First- and second-law analysis with a thorough discussion of entropy generation,
- Availability analysis and how it can be used in thermal analysis,
- Energy and entropy fundamental formulations with generalized work modes and use of the Legendre transformation,
- State relationships for real gases and liquids,
- Thermodynamics of pure fluids,
- Thermodynamics of mixtures including phase equilibrium for a mixture,
- Stability of pure fluids and mixtures, and
- Chemically reacting systems including combustion, equilibrium, and availability analysis.

Analysis of multi-component systems is introduced early in the text and carried through as needed. The introduction to statistical thermodynamics is brief due to the broad range of topics covered. The third and fourth chapters discuss first- and second-law analysis, entropy generation, and availability analysis, while Chapters 6 and 7 cover equations of state and pure fluids. Much of this is covered in undergraduate texts, but repeating it helps introduce the advanced material. The authors include numerous examples, and this material would be useful in design using entropy generation minimization. The nomenclature used in the European literature is introduced which is helpful when reviewing international texts. Chapter 5 is a short one describing thermodynamics in terms of four postulates rather than laws. It deals largely with use of the Legendre transform of the internal energy formulation of the equation of state. The remainder of the book deals with topics generally found in chemical engineering thermodynamics. Chapters 8 and 9 cover non-reacting mixtures. Chapter 11 principally introduces the thermodynamics of combustion and chapters 11-13 cover chemically reacting systems. One addition that would fit in with the aim of the text would be more coverage of psychrometrics. Another would be software to replace the tables of material property data found at the back of the text.

The main criticism this reviewer has for the text is the large number of publishing errors. This reviewer estimates there are several hundred changes that should have been made before the book was printed. It should be stated that, except for the figures, the vast majority of these changes are minor. Examples are inconsistent subscripting of variables, changes in font size, or repeated words. By far, the biggest problem is

the horrendous quality of the figures. In many figures, text was left out or partially obscured or just unreadable. In a few cases, the usefulness of the figure was totally negated. The graphics were of low quality. A comparison of the figures with those in the text from this reviewer's undergraduate thermodynamics class, which was written over 30 years ago, shows that a great deal of improvement is possible.

Writing a text is hard work, and for the authors to catch typing errors is difficult because the mind corrects for mistakes that occur. This reviewer will keep this book on his shelf and anticipates using it because the broad range of topics covered and the numerous examples given make it a good reference text. What this reviewer would really like to have is the corrected version because *Advanced Thermodynamics Engineering* could evolve into an excellent text.

7R53. 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*), AS Myakochin (*Moscow Aviation Inst, Tech Univ, Moscow, Russia*). Begell House, New York. 2002. 392 pp. ISBN 1-56700-167-X. \$85.50.

Reviewed by WS Janna (*Herff Col of Eng, Univ of Memphis, 201E Eng Admin, Memphis TN 38152*).

The authors have written a text for all researchers and engineers interested in the design, production, and testing of heat exchangers. The focus in the text is on enhancing the heat transfer rate. The text was written originally in Russian and was translated into English by Arthur Bergles and William Begell.

The Preface to the first Russian edition, written by the authors, describes the areas in which thermal equipment is widely used. They go on to say that the development of efficient compact heat exchangers is a problem requiring immediate attention, and that there are many publications that address efficient heat transfer surfaces. Large economic losses can be avoided by using them. (Note that the use of the words "efficient surfaces" in the title does not refer to the traditional concept of efficiency as applied to heat transfer from extended surfaces. Rather, the meaning is that by adding extended areas to key surfaces in a heat exchanger, the overall heat transferred in the exchanger can be increased.) The authors provide much detail regarding the physical interaction between coolants and heat transfer surfaces in all problems considered.

The Preface to the English edition, written by the translators, provides a brief history of how the text came to be translated. The translators are "pleased to present the book to heat transfer engineers;" they feel as if they have helped, at least partially, to minimize the distance between the "cultures,

philosophies, and methods" that exist on both sides of the Atlantic and "beyond the Urals."

The Foreword to the English Edition was written by I Z Kopp on behalf of the authors, which contains among other things, an acknowledgment of the work done by the translators.

The first chapter is on modern concepts of heat transfer surfaces and their efficiency. Heat transfer from extended surfaces is discussed here, as is micro- and macrostructure of heat transfer surfaces. Special features of coated surfaces are also addressed, as well as other relevant topics.

The second chapter is on Efficient Surfaces of Convection Heat Transfer. The topics covered here include heat transfer enhancement in straight channels, enhancement in tubes, and enhancement in longitudinal flow past tube bundles and annular channels. Triangular and flat channels are also considered.

Chapter 3 is on Efficiency of Heat Transfer Surfaces in Boiling of Liquids. Nucleation of vapor on real surfaces is discussed as is stable vs unstable nuclei. The chapter concludes with a section that describes an experimental study of boiling on real surfaces with enhancement.

Chapter 4 is about Efficient Heat Transfer Surfaces in Condensation. Surface modifications for which studies have been done include annular grooves on horizontal tubes and on vertical tubes. Also described is the problem of condensation of vapor-air mixtures on vertical and horizontal tubes.

Chapter 5 discusses Efficient Surfaces for Thermal Radiation. Some fundamentals of radiation heat transfer are presented as an introduction. The effect of surface structure on the efficiency of radiative heat transfer is covered, as are finned surfaces, screens, and the effect of intermediate media.

Chapter 6 is about Methods of Calculation and Design of Efficient Heat Transfer Surfaces. The chapter begins with estimating the efficiency of heat transfer enhancement. It continues with a guide to selection of a method of enhancement in channels, and in tubes. Recommendations are given for optimal parameters of turbulizers for different heat exchanger types. The chapter concludes with a section on standard dimensions of turbulizers on tubes.

The next section, References, is 18 pages long and contains 274 entries. Each reference is numbered and listed according to chapter. It appears as if many of the titles have been published in Russian.

The Appendix contains unit conversions, as well as conversion factors. The unit conversion tables and the conversion factor tables contain the same basic information, but they are organized differently and are from different sources.

The index of this text might be considered a bit lengthy. It is nine pages long and prepared in a single-column format. Two col-

umns, single-spaced would reduce the amount of page turning required to find a specific topic.

The text is over 350 pages and contains numerous drawings and graphs. It is basically a literature review of papers and research that pertain to the subject stated in the title. The drawings and graphs are acceptable, although distinctive. The front of the text contains a six-page nomenclature list used in the book. (One difficulty with the nomenclature is that some of the symbols are not what is commonly used in the English literature (eg, n) for viscosity rather than ν).

The text is readable and clearly written. The book is not suitable for use as a classroom textbook, however, because there are no practice problems appearing anywhere. There are no property tables in the text, and there are no calculations that would show specific examples of how to design a heat exchanger surface to enhance heat transfer.

The material would appeal to anyone working with heat exchangers in any capacity as well as to the engineer or researcher desiring to design a surface in a heat exchanger that will enhance heat transfer. *Efficient Surfaces for Heat Exchangers: Fundamentals and Design* would make an excellent addition to any reference library.

7N54. Advanced Computational Methods in Heat Transfer VII. Proc of 7th Int Conf. - Edited by B Sunden (*Lund Inst of Tech, Sweden*) and CA Brebbia (*Wessex Inst of Tech, Southampton, UK*). WIT Press, Southampton, UK. 2002. 558 pp. ISBN 1-85312-906-2. \$285.00.

Heat transfer topics are commonly of a very complex nature. Often different mechanisms like heat conduction, convection, thermal radiation, and nonlinear phenomena, such as temperature-dependent thermophysical properties, and phase change occur simultaneously. Nevertheless, advances in numerical solution methods of partial differential equations and access to high-speed, efficient computers have led to dramatic advances in recent years.

Presenting new approaches to the numerical solution of heat transfer problems, this volume discusses well-established and efficient numerical techniques like finite differences, finite volume, finite elements, and boundary elements. Special attention is also paid to complex thermal problems from engineering practice.

7N55. Heat and Fluid Flow in Microscale and Nanoscale Structures. Developments in Heat Transfer Series, Vol 13. - Edited by M Faghri (*Univ of Rhode Island*) and B Sunden (*Lund Inst of Tech, Sweden*). WIT Press, Southampton, UK. 2002. ISBN 1-85312-893-7. \$231.00.

Fundamental and applied investigations of microscopic phenomena of thermal processes have been demanded by recent developments in microelectronics, laser-based systems, micro heat exchangers, micro heat pipes, sensors, and actuators. Micro cooling technology has been developed in response to the need for thermal control in the fabrication and operation of such micro- and nanoscale devices. In addition to meeting the microscale size requirements, micro cooling devices must be capable of accommodating extremely high heat flux loads. Extensive research is now taking place internationally, and this book presents state-of-the-art advances in this field on the following topics: microscale energy transport in solids; energy transfer and conversion in micro- and nanoscale; heat conduction in micro-

structures; convective rarefied or low density gaseous flow and heat transfer; radiative energy transport on the microscale; micro heat pipes; microscale energy systems; microscale refrigeration; micro-machining technologies.

7N56. Heat Transfer in Gas Turbines. Developments in Heat Transfer Series, Vol 8. - Edited by B Sunden (*Lund Inst of Tech, Sweden*) and M Faghri (*Univ of Rhode Island*). WIT Press, Southampton, UK. 2002. 536 pp. ISBN 1-85312-666-7. \$247.00.

Gas turbine engines and systems are designed to convert the energy of a fuel into some form of useful power, such as mechanical shaft power, electrical power, or the high-speed thrust of a jet. Research and development designed to perfect efficient cooling in gas turbines require fundamental and applied investigations of heat transfer.

Containing invited contributions from specialists working in this field, this title reflects current active research and covers a broad spectrum of heat transfer phenomena in gas turbines. All of the chapters follow a unified outline and presentation to aid accessibility.

7N57. Proceedings of the ASME Advanced Energy Systems Division - 2001. Proc of ASME Congress, Nov 2001, New York. - Edited by A Hernandez-Guerrero, H Metghalchi, RB Peterson, MM Rahman, BG Shiva Prasad. ASME, New York. 2001. 632 pp. ISBN 0-7918-3552-9. ASME Book No I00520. \$230.00. (ASME members \$165.00).

This annual compilation of 73 full-length, peer-reviewed papers covers the following areas: Direct thermal energy conversion/thermal management technologies and systems; heat pump and refrigeration systems design, analysis, and application; micro and mesoscale energy systems and conversion devices; and thermodynamics and design, analysis, and improvements of energy systems.

Advanced Boundary Elements for Heat Transfer. Topics in Engineering, Vol 42. - M-T Ibanez (*Wessex Inst of Tech, Southampton, UK*) and H Power (*Univ of Nottingham, UK*). WIT Press, Southampton, UK. 2002. 134 pp. ISBN 1-85312-898-8. \$99.00. (Under review)

Non-Smooth Thermomechanics. - M Fremond (*Laboratoire Lagrange, LCPC, 58 Blvd Lefebvre, Paris Cedex 15, 75732, France*). Springer-Verlag, Berlin. 2002. 480 pp. ISBN 3-540-66500-5. \$89.95. (Under review)

VII. EARTH SCIENCES

7R58. Continuum Mechanics and Applications in Geophysics and the Environment. - Edited by B Straughan (*Dept of Math Sci, Univ of Durham, Durham, DH1 3LE, UK*), R Greve, H Ehrentraut, Yongqi Wang (*Fachbereich Mechanik, Tech Univ Darmstadt, Hochschulstr 1, Darmstadt, 64289, Germany*). Springer-Verlag, New York. 2001. 393 pp. ISBN 3-540-41660-9. \$79.95.

Reviewed by LA Glenn (*Computational Phys Group, Geophys Div, MS L-200, LLNL, 7000 East Ave, Livermore CA 94550-9900*).

This book is a collection of papers dedicated to Professor Kolumban Hutter of the Darmstadt University of Technology on the occasion of his 60th birthday. The papers are broadly organized into four categories,

namely applied continuum mechanics, soil mechanics, and porous media, glacier and ice dynamics, and climatology and lake physics. Altogether there are 19 topics covered, and the subject matter varies widely, even within a category.

In the first part, covering applied continuum mechanics for example, the six contributions deal respectively with shock waves in a radiating gas, anisotropic fluids (in which category the author includes granular materials!), miscibility, nonlinear diffusion models, the second sound phenomenon in crystals, and electro-mechanical coupling with piezoelectric actuators. The short paper on miscibility approaches the subject from an especially unique viewpoint, ie, by exhibiting an analogy between a population of hawks and doves who individually behave differently in the contest for a resource, and a mixture of two constituents in two phases.

The four papers that focus on soil mechanics or porous media are similarly diverse. The first deals with the problem of a heap of grains that is driven by gravity down an incline and develops the theory that allows the evolution of the shape of the heap and the depth-averaged velocity to be determined. The second investigates the nature of the boundary at the interface between a porous region and a clear fluid. The third deals with numerical techniques for solving eigenvalue problems which arise in convection driven instability problems in porous media. The final contribution in this part discusses the application of the mechanics of multiphase porous media to unsaturated soils.

Next come five articles on glacier and ice dynamics. The first two of these examine the physics of iceberg drift and the flow of glaciers and ice sheets. These are followed by two papers dealing with the shallow-ice-approximation, the first describing computational methods and algorithms, and the second an asymptotic method for the analysis of steady plane nonlinearly viscous flow of ice sheets. This section is rounded out by an article on constitutive modeling and flow simulation of anisotropic polar ice.

Part four leads off with a discussion of models for the response of the earth to temporally varying ice loads and continues with two articles on climate modeling, the first aimed at arctic sea ice and its role in climate variability, and the second with a presentation of simple models that help in understanding climate change. The final paper in this grouping compares different numerical treatments of advection terms for wind-induced circulations in Lake Constance at the crossroad between Germany, Switzerland, and Austria.

Continuum Mechanics and Applications in Geophysics and the Environment is primarily intended for active researchers interested in geophysical modeling. The papers are connected only broadly and in the sense that they touch in some way on Professor

Hutter's main interests. As with most collections of this type, the editing has been minimal, and there is no index. Although most of the material can be found in other places, this is a nice collection and should be a welcome addition to one's personal library.

7R59. Dynamics of Internal Gravity Waves in the Ocean. - YZ Miropol'sky (*PP Shirshov Inst of Oceanology, Russian Acad of Sci, Moscow, Russia*). Kluwer Acad Publ, Dordrecht, Netherlands. 2001. 406 pp. ISBN 0-7923-6935-1. \$149.00.

Reviewed by O Phillips (Dept of Earth and Planet Sci, Johns Hopkins Univ, Charles and 34th St, Baltimore MD 21218-2681).

Internal gravity waves occur in the atmosphere and oceans as a result of their internal density stratification. In the atmosphere, the flow is sometimes visualized naturally by rows of cloud bands, condensation regions near the wave crests. In the oceans, they have excited intense interest because of their strong effects on acoustic propagation. To a fluid mechanician, they offer a beautiful array of phenomena, mostly as a consequence of their anisotropy (the restoring force in the oscillation, gravity, acts only vertically). These waves can be demonstrated vividly in simple laboratory experiments; their phase and group velocities are orthogonal, their frequency range is bounded, their wavelength changes on reflection from a sloping bottom, and when the stratification varies in the vertical, there can be internal trapping and things like that.

This beautiful book, a graduate-level text and reference, is a poignant epitaph to its young author, whose premature death has saddened his many intellectual colleagues throughout the world. Its development of the basic dynamical theory is clear and comprehensive, starting with the linear theory of propagation in a horizontally homogeneous, but vertically stratified medium that is otherwise at rest. It continues by inclusion of horizontal shear with the possibility of critical layers, and proceeds to discussion of horizontal inhomogeneities. Internal waves seem to be generated ubiquitously in nature. A number of generation mechanisms are known, but as Miropol'sky freely admits, there are still a few things to be understood here. The Hamiltonian formulation for weak nonlinear fields, solitons, and resonant wave interactions lead to two short but informative chapters on ocean measurements and laboratory experiments.

The qualities of this book remind us of why the author was regarded as one of the brightest leaders in this area of fluid mechanics. It is written comprehensively and authoritatively, with clarity and grace. It is, in places, demanding of the mathematical skills of the reader, but only when necessarily so. The line diagrams are fine, but it might have been helpful to have had a few good photographs of some pivotal experi-

ments, such as there are in JS Turner's book, *Buoyancy Effects in Fluids*. The translation by OD Shishkina is excellent—smooth and accurate.

It is probable that here we may have a new classic in the field and, though the price is a bit steep, *Dynamics of Internal Gravity Waves in the Ocean* should be in the library of every serious fluid dynamicist and dynamical oceanographer or meteorologist.

7R60. Transport Modeling in Hydrogeochemical Systems. Interdisciplinary Applied Math, Vol 15. - JD Logan (*Dept of Math and Stat, Univ of Nebraska, Lincoln NE 68588-0323*). Springer-Verlag, New York. 2001. 223 pp. ISBN 0-387-95276-4. \$69.95.

Reviewed by J Koplik (Levich Inst, CCNY, 138 St and Convent Ave, New York NY 10031).

The book is a very well-written monograph which discusses the theory and some analytic solution methods for a number of the partial differential equations (PDEs) which arise in modeling transport processes in geological situations. The book is designed to appeal to both the mathematics and applications communities, and it does a good job of presenting interesting material on both aspects. While quite readable on its own, the book could be used for a special topics course in either applications of PDEs or the mathematics of transport phenomena, respectively, for its two intended audience groups.

The transport phenomena considered here are diffusion, advection, adsorption, and reaction, usually expressed in terms of a single PDE, or occasionally a coupled system of them.

The general theory covers boundary conditions, Greens' functions, maximum principles, wave propagation, some aspects of stability and nonlinearity, and numerous tricks which prove useful in particular situations. Numerical methods are very briefly discussed in appendices. The principal applications are to groundwater transport, filtration processes, solution kinetics, and reactive fluid flows. The physical basis of the equations considered is given in enough detail to be convincing to all but the specialist, and in a way that allows the mathematical results to be interpreted physically. The motivation for the models studied, the relevant PDE theory, and the applications to specific problems are all presented in a unified fashion, rather than sequentially, and as a result one gets a feeling for the subject instead of a collection of facts.

The mathematical level is that of graduate students in mathematical sciences or engineering, meaning that the prerequisite is something along the lines of a standard graduate mathematical methods course, the basic theorems are proven in a convincing, but non-rigorous way, and some of the less trivial general results are left for the refer-

ences. A mathematics student or a person who has previously studied partial differential equations might find these parts of the book elementary or familiar, but could still learn a great deal from the numerous examples included.

The book is not quite a practical guide, since it emphasizes problems which have an interesting PDE aspect to them and in addition focuses on "clean" mathematical problems, without delving into the effects of material heterogeneity and uncertainty in modeling parameters, which are often the major difficulties in real situations. However, the insight obtained from the basic mathematics is certainly presented clearly. The typography in the book is attractive, the figures are clear, and the price is typical for volumes of this sort. The general references to the mathematics literature are fine, but those to the applications seem somewhat limited to the author's experience and interests. *Transport Modeling in Hydrogeochemical Systems* is certainly suitable for libraries and as a collection of problems for a general PDE course. It would be a useful reference and source of hints for engineers and scientists studying transport problems.

7N61. Atmosphere-Ocean Interactions, Vol 1. - Edited by W Perrie (*Bedford Inst of Oceanog, Canada*). WIT Press, Southampton, UK. 2002. 420 pp. ISBN 1-85312-892-9. \$215.00.

This volume provides an overview of current developments in theoretical aspects of atmosphere-ocean interactions. These include the fundamental influence of the ocean surface on atmospheric dynamics and also the impact of atmospheric phenomena on the upper ocean. Both large scale ocean-atmosphere dynamics, including low frequency variability, as well as shorter time-scales, such as the physics of the atmospheric and oceanic boundary layers and their interactions with surface waves and related air-sea processes important in marine storms are considered. The text also includes some recent research results.

7N62. Geomorphological Fluid Mechanics. Lecture Notes in Physics, Vol 582. - Edited by NJ Balmforth (*Sch of Eng, Univ of California, 1156 High St, Santa Cruz, CA 95064*) and Provenzale (*Istituto di Scienze dell'Atmosfera e del Clima, CNR, Corso Fiume 4, Torino 10133, Italy*). Springer-Verlag, Berlin. 2001. 578 pp. ISBN 3-540-42968-9. \$99.00.

Geomorphology deals with some of the most striking patterns of nature. From mountain ranges and mid-ocean ridges, to river networks and sand dunes, there is a whole family of forms, structures, and shapes that demand rationalization as well as mathematical description. In the various chapters of this volume, many of these patterns will be explored and discussed, and attempts will be made to unravel the reasons for their dynamics in quantitative terms. Particular focus will be on lava and mud flows, ice and snow dynamics, river and coastal morphodynamics, and landscape formation. This volume combines a pedagogical approach with up-to-date reviews of forefront research.

Air-Sea Interaction: Laws and Mechanisms. - GT Csanady (*Old Dominion Univ, Norfolk VA*). Cambridge UP, Cambridge, UK. 2001. 239 pp. (Softcover). ISBN 0-521-79680-6. \$95.00. (Under review)

Macroscale Models of Flow Through Highly

Heterogeneous Porous Media. Theory and Applications of Transport in Porous Media, Vol 16. - M Panfilov (*Oil & Gas Research Inst, Russian Acad of Sci, Moscow, Russia*). Kluwer Acad Publ, Dordrecht, Netherlands. 2000. 363 pp. ISBN 0-7923-6176-8. \$148.00. (Under review)

Seismic Ray Theory. - V Cerveny (*Charles Univ, Praha, Czech Republic*). Cambridge UP, Cambridge, UK. 2001. 713 pp. ISBN 0-521-36671-2. \$95.00. (Under review)

VIII. ENERGY & ENVIRONMENT

7N63. Advances in Environmental Fluid Mechanics: Science, Technology and Policy. From Int Conf of Env Hydraulics. - Edited by HJS Fernando and DL Boyer (*Dept of Mech and Aerospace Eng, Arizona State Univ, Tempe AZ 85287-9809*). WIT Press, Southampton, UK. 2002. 300 pp. ISBN 1-85312-932-1. \$153.00.

This is a state-of-the art review of various disciplines within environmental fluid mechanics, together with associated public policy issues and future directions. Invited contributions from a diverse group of distinguished specialists in such areas as fluid mechanics, hydraulics, meteorology, hydrology, oceanography, and related public policy issues are included.

7N64. Development and Application of Computer Techniques to Environmental Studies IX. Proc of 9th Int Conf on the Modeling, Monitoring, and Management of Environmental Problems (ENVIROSOFT). - Edited by CA Brebbia (*Wessex Inst of Tech, Southampton, UK*) and P Zannetti (*EnviroComp Consulting*). WIT Press, Southampton, UK. 2002. 410 pp. ISBN 1-85312-909-7. \$209.00.

This book presents the recent developments and practical implementations in the theoretical, numerical, and applicable aspects of computer analysis, simulation, modeling, control, and forecasting for environmental applications.

Papers cover environmental modeling, algorithms, software codes, and other topics related to the scope and application of computer programs to environmental issues.

7N65. Fluid Mechanics and the Environment: Dynamical Approaches. - Edited by JL Lumley (*Cornell Univ, Ithaca NY*). Springer-Verlag, New York. 2001. 412 pp. ISBN 3-540-41475-4. \$74.80.

This is a collection of research papers written in commemoration of the 60th birthday of Sidney Leibovich.

7N66. Mesoscale Atmospheric Dispersion. Advances in Air Pollution Series, Vol 9. - Edited by Z Boybeyi (*Sci Applications Int VA*). WIT Press, Southampton, UK. 2001. 448 pp. ISBN 1-85312-732-9. \$262.00.

In the last few decades, there has been increasing recognition and interest in evaluating air pollution problems over mesoscale and synoptic-scale. This monograph presents a collection of invited review papers covering this complex phenomenon. All the contributions have been written by leading scientists in the field and provide the reader with organized and consistent discussions on different aspects of mesoscale atmospheric dispersion. The material featured will be of interest to researchers and students examining mesoscale meteorology, mesoscale dispersion, atmospheric boundary layer, and air pollution meteorology.

Environmental Stratified Flows. Topics in Environmental Fluid Mechanics, Vol 3. - Edited by R Grimshaw (*Dept of Math Sci, Loughborough Univ, UK*). Kluwer Acad Publ, Dordrecht, Netherlands. 2002. 284 pp. ISBN 0-7923-7605-6. \$135.00. (Under review)

IX. BIOENGINEERING

7N67. 2001 Advances in Bioengineering. Proc of ASME Congress, Nov 2001, New York. - Edited by BB Lieber. ASME, New York. 2001. 360 pp. ISBN 0-7918-3547-2. ASME Book No 100515. \$150.00. (ASME members \$75.00).

This annual collection of two-page, peer-reviewed technical papers covers the following: student paper competition (bachelor's, master's, and doctoral levels); biomechanics education; spine biomechanics; joint biomechanics; cardiovascular fluid/solid mechanics; cardiovascular device mechanics; micro, injury, and surgical biomechanics; cell mechanics; implant biomechanics and technology; vehicular and pediatric; pulmonary devices; cardiovascular solid mechanics; cartilage mechanics interactions; sports and sports injuries; tissue engineering; minimally invasive surgery; medical device design; bone mechanics; biomechanics; joint biomechanics; soft tissue mechanics; cardiovascular fluid mechanics; heat and valve mechanics; and nano and micro mechanics.

7N68. Computational Modeling in Biological Fluid Dynamics. IMA Volumes Mathematics, Vol 124. - Edited by LJ Fauci (*Tulane Univ, New Orleans LA*) and S Gueron (*Technion-Israel Inst of Tech, Haifa, Israel*). Springer-Verlag, New York. 2001. 256 pp. ISBN 0-387-95233-0. \$69.95.

This volume contains invited and refereed papers based upon presentations given in an IMA workshop which was part of a year-long program, *Mathematics in Biology*.

7N69. Crashworthiness, Occupant Protection, and Biomechanics in Transportation Systems - 2001. Proc of ASME Congress, Nov 2001, New York. - Edited by HF Mahmood. ASME, New York. 2001. 184 pp. ISBN 0-7918-3581-2. ASME Book No 100549. \$100.00. (ASME members \$50.00).

This is a collection of 23 full-length, peer-reviewed technical papers emphasizing the shape of the latest research, development, and applications in crashworthiness, occupant protection, and biomechanics by experts in the academic and industrial spheres. Topics covered include aluminum design for crashworthiness; nonlinear finite element and rigid body modeling; component and vehicle testing; composite structure; inflatable tubular structure air bag; occupant responses in frontal impact; seat system performance in rear impact; FE modeling of human thorax; traumatic brain injuries; and cervical spine injuries.

Biological Micro- and Nanotribology: Nature's Solutions. NanoScience and Technology Series. - M Scherge (*IAVF Antriebstechnik AG, Im Schleiert 32, Karlsruhe, 76187, Germany*) and SS Gorb (*Biologische Mikrottribologie Gruppe, MPI fur Entwicklungsbiologie, Spemannstr 35, Tubingen, 72076, Germany*). Springer-Verlag, New York. 2001. 304 pp. ISBN 3-540-41188-7. \$74.95. (Under review)

Cardiovascular Solid Mechanics: Cells, Tissues, and Organs. - JD Humphrey (*Dept of Biomed Eng, Texas A&M Univ, College Station TX 77843-3120*). Springer-Verlag, New York. 2002. 757 pp. ISBN 0-387-95168-7. \$99.00. (Under review)

X. GENERAL & MISCELLANEOUS

7N70. Handbook of Linear Partial Differential Equations for Engineers and Scientists. -

Edited by AD Polyanin (*Russian Acad of Sci, Moscow, Russia*). Chapman and Hall/CRC, Boca Raton FL. 2001. 800 pp. ISBN 1-58488-299-9. \$129.95.

This handbook presents brief formulations and exact solutions for more than 2,200 equations and problems in science and engineering. Topics covered include parabolic, hyperbolic, and elliptic equations with constant and variable coefficients; new exact solutions to linear equations and boundary value problems; equations and problems of general form that depend on arbitrary functions; formulas for constructing solutions to nonhomogeneous boundary value problems; and second- and higher-order equations and boundary value problems. This handbook also presents solutions to numerous problems re-

lated to heat and mass transfer, wave theory, acoustics, elasticity, hydrodynamics, electrostatics, quantum mechanics, and other fields of science and engineering.

7N71. Proceedings of the 2001 ASME Design Engineering Technical Conferences and Computers and Information in Engineering Conference - Print Version, Vol 6. From DETC 2001, Sept 2001, Pittsburgh. - ASME, New York. 2001. 3372 pp. ISBN 0-7918-3546-4. ASME Book No IX0514. \$500.00. (ASME members \$250.00).

There are 385 full-length, peer-reviewed technical papers included in this volume on the following topics: multibody dynamics and vibration; rotating structures and machinery; dynamics and control of time-varying systems and struc-

tures; friction induced vibration; active, passive, and hybrid vibration control; noise control with simulation-based design; modeling and simulation of structures with jointed interfaces; vibration of continuous systems; vibration studies on smart laminated composites; vibration of nonlinear mechanical systems; nonlinear normal modes for systems with non-smooth nonlinearities; wavelet and time-frequency analysis and applications; system identification, order reduction, and fault detection; dynamics and stability of time-varying systems; vibration and control of non-smooth dynamical systems; piezoelectric actuators; smart mechanical systems; vibration including friction and impacts; dynamics and control of moving load systems; dynamics and vibration of robotic systems; experiments with nonlinear dynamic systems; and nonlinear dynamics and control of engineering systems.

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