BOOK REVIEWS

I. FOUNDATIONS & BASIC METHODS

1R1. Tensor Analysis and Continuum Mechanics. - YR Talpaert *(Dept of Sci and Eng, Algiers Univ, Algeria).* Kluwer Acad Publ, Dordrecht, Netherlands. 2002. 591 pp. ISBN 1-4020-1055-9. $161.00.

Reviewed by JG Simmonds (Dept of Civil Eng, Univ of Virginia, Thornton Hall, Charlottesville VA 22903).

This is a carefully written treatise that begins by (over?) developing the tensor machinery necessary to state and manipulate various global and local forms of the general equations of continuum mechanics (conservation of mass, translational and rotational momentum, first and second laws of thermodynamics, excluding chemical and electromagnetic effects). Each of the book's six chapters ends with a good number of worked-out exercises. Although considerable attention is given to the kinematics and kinetics of deforming continua, the important topic jumps and shocks are not treated and the only specific constitutive relations considered are those of linear elasticity, mostly for isotropic bodies.

However, no matter how well done, one must ask in such a well-plowed field as continuum mechanics if a new book supercedes in any way—novelty of presentation, new insights into well-established principles and equations, range of phenomena, or variety of constitutive relations—some of the older, standard treatments, such as those of Truesdell and Toupin (1960), Truesdell and Noll (1965), Chadwick (1976), Spenser (1980), Gurtin (1981), or Truesdell (1984, 1991). Unfortunately, in my opinion, the answer is ''No.'' (Incidentally, none of the books just cited appears in the author's list of references.)

By no means am I implying that continuum mechanics is a closed field. But it seems to me that today's focus is on the establishment, analysis, and implications of ever more comprehensive constitutive relations, an area that the author of the book under review barely touches.

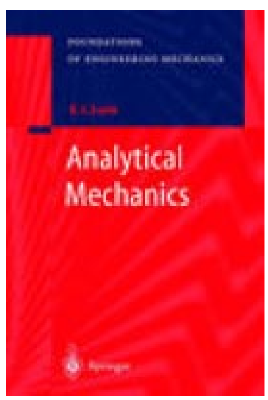
In summary, *Tensor Analysis and Continuum Mechanics* is a sound, well-written book, suitable for a first-year graduate course, but researchers in the various branches of continuum mechanics will find little that is new.

II. DYNAMICS & VIBRATION

1R2. Analytical Mechanics. Foundations of Engineering Mechanics Series. - AI Lurie *(Saint-Petersburg Polytechnic Inst, Russia).* Springer-Verlag, Berlin. 2002. 864 pp. ISBN 3-540-42982-4. $139.00.

Reviewed by W Schiehlen (Inst B of Mech, Univ of Stuttgart, Pfaffenwaldring 9, Stuttgart, 70550, Germany).

This book by AI Lurie is a most valuable contribution to the foundations of engineering mechanics. Even if the original Russian edition of the book was published in 1961, the English translation reviewed is still a topical textbook of theoretical mechanics. The book is based on the definition of a material body as a collection of particles resulting in a finite number of degrees of freedom. The continuum mechanics approach, which is more standard today even for rigid bodies, is only mentioned, but not considered in detail. Thus, the theory presented fits perfectly to multi-particle systems, rigid and elastic frameworks, and celestial mechanics. Rigid bodies and gyroscopes are also covered assuming that their inertia parameters are known.



Chapter 1 is devoted to the basic definitions of engineering systems of material particles characterized by constraints between the particles. Based on this concept, generalized coordinates, velocities and accelerations, redundant coordinates, quasi-velocities, and virtual displacements are introduced. As an example, a two-axle trolley is used.

The second chapter deals with rigid bodies kinematics. Direction cosines and Euler angles are presented with special emphasis on airplane and ship angles. From the vector of infinitesimal rotation, the angular velocity is derived. The matrix form for velocity and acceleration of a rigid body is given. Further, the relative motion with respect to generalized coordinates is analyzed. Applications include Cardan's suspension and a body rolling on a fixed plane. Chapter 3 presents the theory of finite rotations of rigid bodies. Starting with Rodrigues formula, the corresponding Rodrigues and Hamilton parameters, the Euler-Chasles theorem, and the relation between finite rotations and Euler angles are introduced. A complex valued combination of Rodrigues-Hamilton parameters results in Cayley-Klein parameters. The angular velocity vector for finite rotations is also derived for Cayley-Klein's parameters. The evaluation of the position of a self-excited rigid body serves as an example.

The fourth chapter specifies the basic dynamic quantities as kinetic energy, momentum and angular momentum, and the energy of accelerations required for Appel's equations later on. All these quantities are based on the tensor of inertia discussed in detail. Examples deal with Cardan's suspension, flywheels, rotor platforms, rolling spheres and rings, and the two-axle trolley. In Chapter 5, the mechanical work and the related potential energy are discussed resulting in generalized forces due to gravity and elasticity. With respect to space applications also the shape of the Earth is considered. The potential energy is evaluated for rod structures subject to bending, torsion, and compression. Dissipative forces due to friction and aerodynamic resistance are analyzed.

Chapter 6 presents Lagrange's equations of the first kind. For ideal constraints without any dissipation, one gets the fundamental equations of dynamics also known as D'Alembert's principle or Lagrange's central equations, respectively. The examples deal with the equilibrium of systems of particles, in particular, rod structures and rigid bodies including friction. Then, in Chapter 7, Lagrange's equations of the second kind are derived. The structure of these equations is discussed, and a geometrical interpretation of the motion of the system is given. Even if the reaction forces are removed, it is shown how generalized forces are retained and computed efficiently. Cyclic coordinates and the Routhian function are presented. Numerous examples are found throughout this chapter like rod systems, slider-crank mechanisms, and heavy tops.

In Chapter 8, special forms of differential equations for nonholonomic systems are considered. Based on quasi-velocities defined as linear forms of generalized velocities, the Euler-Lagrange differential equations are found, and Appell's differential equations are presented. Applications include rolling spheres and rings as well as the two-axle trolley. Chapter 9 is devoted to the dynamics of relative motion. From the corresponding differential equations, the relative equilibrium of rotating shafts and gyroscopes is investigated as well as the motion of rigid bodies filled with fluid, and rocket problems.

Chapter 10 deals with the Hamilton canonical equations of motion using generalized momenta in addition to the generalized coordinates. The properties of canonical transformations result in Jacobi's theorem for the integral of canonical systems. As an example, the Keplerian motion of a particle in a central force field is chosen. The perturbation theory of Chapter 11 is based on the canonical equations and applied to satellites in the gravitational field of the rotating Earth and to unbalanced heavy tops. Further, the equations for the perturbed motion of a particle are given.

Finally, the variational principles of mechanics are treated in the long Chapter 12. From Hamilton's action follows Hamilton's principle denoted as Hamilton-Ostrogradsky principle. Applications to nonholonomic systems and distributed systems like hanging chains and rotating rods are included. The approximate determination of natural frequencies and normal forms is presented for the rotation of a nearly vertical gyroscope. Two appendices on matrix theory and tensor calculus complete the book. A nice list of references as of 1961 and an informative index are also included.

The author succeeded very well with his aim to state problems and to generate the equations of motions of discrete mechanical systems. In particular, the numerous examples show how the methods presented are to be applied to real engineering problems. In contrary to Western literature, only vectors and not matrices are printed in bold characters. Nevertheless, the book is easily readable. The translation is perfect from a science and a language point of view. Therefore, *Analytical Mechanics* is recommended to graduate students, and to researchers and engineers in industry interested in a rigorous presentation of analytical mechanics. Further, this book should be available in any scientific library.

1R3. Computer Algebra Recipes for Classical Mechanics. - RH Enns *(Dept of Phys, Simon Fraser Univ, Burnaby, BC, V5A 1S6, Canada).* and GC McGuire *(Dept of Phys, Univ Col of Fraser Valley, Abbotsford, BC, V2S 7M9, Canada). Birkhauser Boston,* Cambridge MA. 2003. 264 pp. Softcover, CD-Rom included. ISBN 0-8176-4291-9. $54.95.

Reviewed by WE Clausen (7521 Heffley Court, Canal Winchester OH 43110-8749).

Computer Algebra Recipes for Classical Mechanics is a guide to problem solving in classical mechanics using the Maple 8 computer algebra system. Computer algebra systems allow one not only to carry out the numerical computations of standard programming languages, but also to perform complicated symbolic manipulations. A computer algebra system can perform a wide variety of mathematical operations, including analytic differentiation and analytic/numerical integration, analytic/numerical solution of ordinary/partial differential equations, Taylor series expansions of functions to arbitrary order, analytic/numerical solution and manipulation of algebraic equations, production of two and three-dimensional vector field and contour plots, and animation of analytic and numerical solutions

The book is designed to complement traditional textbooks by showing how computer algebra can be used to solve standard physical models efficiently and to explore more complex physical systems. The heart of this book consists of a set of more than one hundred computer algebra worksheets (the "recipes"), which are systematically organized to correlate with the topics covered in standard undergraduate mechanics texts. A reader desiring to use an alternate computer algebra system or a different release of Maple may have little difficulty in modifying the recipes.

No prior knowledge of Maple is assumed, the relevant command structures being systematically introduced on a need-to-know basis. Each recipe takes the reader from the analytic formulation of a representative type of mechanics problem to its solution (analytical or numerical) to a graphical visualization of the solution. The graphical representations vary from static two-dimensional pictures, to contour and vector field plots, to three-dimensional graphs, which can be rotated, to animations in time. All the recipes are included on the CD that accompanies the book.

The authors have designed each recipe so that by altering the parameter values, or the initial conditions, or the very nature of the model itself, additional mechanics problems can be studied.

The recipes are organized into three levels:

- In the *Appetizers*, the recipes assume a familiarity with the fundamental concepts of mechanics (eg, kinematics, Newton's laws with constant forces, conservation of energy and momentum etc) and a mathematical knowledge of vectors, ordinary derivatives, integrals, and linear algebra.
- The *Entrees* deal with examples from intermediate mechanics (eg, Newtonian dynamics with variable forces and accelerated frames of reference) and make use of partial derivatives, vector calculus, curvilinear coordinates, and linear and nonlinear ordinary differential equations.
- In the advanced mechanics recipes, which form the *Desserts*, the focus is on examples from Lagrangian and Hamiltonian mechanics.

The text contains forty-seven problems that have full solutions with the Maple code provided and explained. The problem statements for sixty-six supplementary problems are also included in the text. The CD, which accompanies the book, includes the Maple code for all 113 problems with extensive comments provided for the supplementary problems. The problems are appropriate and imaginative and the solutions take full advantage of the latest revisions in the Maple 8 computer algebra system so that few problems can be solved using earlier Maple releases.

III. AUTOMATIC CONTROL

1R4. CMOS Cantilever Sensor Systems: Atomic Force Microscopy and Gas Sensing Applications. - D Lange *(Dept of Elec Eng, Stanford Univ, CIS 205-x, Stanford CA 94305-4075),* O Brand *(Phys Electron Lab, ETH Zurich, ETH Hoenggerberg, HPT-H4.2, Zurich, 8093, Switzerland),* H Baltes *(Phys Electron Lab, ETH Zurich, ETH Hoenggerberg, HPT-H6, Zurich, 8093, Switzerland).* Springer-Verlag, Berlin. 2002. 142 pp. ISBN 3-540-43143-8. $64.95.

Reviewed by T Krzyzynski (Dept of Mech Eng, Koszalin Univ of Tech, Raclawicka 15-17, Koszalin, 75-620, Poland).

This is a book constitutes an introduction into the development of cantilever-based sensor systems using CMOS-compatible micromachining. The authors who deal with such a problem from the design concepts and simulations to the prototype, addresses their book to scientists and engineers active in the field of micro- and nano-electro-mechanical systems, as well as to researchers on cantilever sensors and resonant sensors in general.

This book consists of six chapters, four appendices, references, and a subject index. Chapter 1 (Introduction) contains a background and motivation of the research carried out mostly at the Physical Electronics Laboratory of ETH Zürich.

Chapter 2 (Design Considerations) deals with mathematical fundamentals that are necessary for the design and production of cantilevers as mass-sensitive sensors or force sensors.

Chapter 3 (Cantilever Beam Resonators) is devoted to presentation of experimental characteristics illustrating resonant behavior of CMOS-based cantilever beams, including stability analysis of such an oscillator system.

Chapter 4 (Resonant Gas Sensor) is addressed to practical application of cantilever beams described in Chapter 3 - a mass-sensitive gas sensor system for the detection of Volatile Organic Compounds in air.

Chapter 5 (Force Sensors for Parallel Scanning Atomic Force Microscopy) is dedicated to the second application of the resonant cantilevers. Experimental data in a case of a 2-cantilever array are presented and discussed. A next generation of cantilever force sensors, composed of 10 elements in an array, results from finite element simulation carried out by the authors.

Chapter 6 (Conclusions and Outlook) is focused on a brief overview of the book content and perspectives of further research, especially with the ongoing trend to further miniaturization and the expansion of nanotechnology.

Four appendices contain: (1) Process Sequence Resonant Gas Sensor; (2) The same but maskless; (3) Process Sequence Atomic Force Microscopy Sensor Arrays; (4) Material Properties of Thin Film Materials.

The structure of the book makes it possible to study the problems considered in an effective and very inspiring way.

In the reviewer's opinion, *CMOS Cantilever Sensor Systems: Atomic Force Microscopy and Gas Sensing Applications* is very useful for both researchers and advanced students. This book can serve as a resource for engineers and scientists as well, and is recommended for their libraries.

1R5. Nonholonomic Mechanics and Control. - AM Bloch *(Dept of Math, Univ of Michigan, Ann Arbor MI 48109-1109).* Springer-Verlag, New York. 2003. 483 pp. ISBN 0-387-95535-6. $69.95.

Reviewed by B Brogliato (INRA, 655 Ave De L'Europe, Saint Ismier, 38334, France).

This mathematically oriented book is dedicated to the modeling and control of a class of nonlinear mechanical systems, namely mechanical systems subject to nonholonomic (or non integrable) bilateral constraints. It is known that the control of such nonlinear systems requires specific tools, as they may not be stabilizable with continuous feedbacks, as a consequence of Brockett's necessary conditions. Such problems have received considerable attention in the applied mathematics, mechanics, and systems and control communities, for many years. Therefore, this is a topic of major importance. The audience will mainly consist of graduate students, researchers, either working in this field or with a sufficiently advanced mathematical background (especially differential geometry tools).

The book starts with an introductory chapter with many examples treated in detail. The next two chapters are devoted to presenting the mathematical tools needed to study such systems. This material will certainly be hard to follow for those who have no acquaintance in differential geometry and its applications to mechanics. However, in view of the literature on the subject, understanding the basics from geometry seems to be mandatory for someone who wants to understand the control of such mechanical systems. The fourth chapter is dedicated to nonlinear control theory, still with an emphasis on geometry. Controllability, stability and stabilization are reviewed, and the chapter ends with Hamiltonian and Lagrangian control systems. The fifth and sixth chapters are devoted to nonholonomic systems, their dynamics and their control. Stabilization techniques are explained, like time-varying and nonsmooth controllers. Here one can regret that the bibliography omits C Samson, one of the first contributors to the field and who introduced time-varying controllers for the control of chained systems in the paper *Velocity and torque feedback control of a nonholonomic cart*, in Advanced Robot Control, Proceedings of the International Workshop on Nonlinear and Adaptive Control: Issues in Robotics, Grenoble, France, November 21-23, 1990, Springer Verlag LNCIS 162. Samson's paper *Control of chained systems*: *Application to path following and time-varying point stabilization*, IEEE Trans on Automatic Control, Volume 40, pp 64-77, 1995, would have also been welcome in the bibliography. Chapter 7 deals with optimal control and variational principles. The eighth chapter concerns stability analysis with energy arguments (generalization of the Lejeune-Dirichlet theorem on stability of fixed points). In a logical way the last chapter is devoted to energy-based control and stabilization.

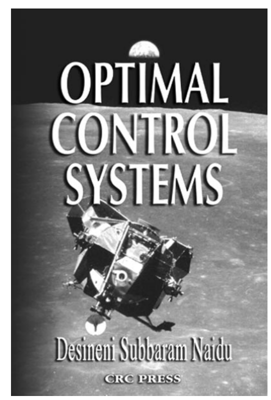
There are many other books that cover the topic of nonholonomic mechanical systems control in one or two chapters (for instance Sastry's book in the same Springer's series, or the book *Theory of Robot Control*, Springer CCE Series, 1996). But *Nonholonomic Mechanics and Control* is entirely dedicated to this topic and covers the aspects of modeling, analysis and control. It clearly belongs to the realm of geometry-oriented works in mechanics or control. The book is well organized, contains many examples and exercises, and can be recommended to all researchers working in the field (applied mathematics, mechanics or control).

1R6. Optimal Control Systems. - DS Naidu *(Idaho State Univ, Pocatello ID).* CRC Press LLC, Boca Raton FL. 2003. 433 pp. ISBN 0-8493-0892-5. $99.95.

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

The book, *Optimal Control Systems*, by DS Naidu provides an introduction to key concepts and methods of the optimal control theory for deterministic continuous-time and discrete-time finite-dimensional dynamic systems. The material of the book is based on the author's experience teaching graduate level optimal control courses and has grown out of the lecture notes used by the author in these courses.

After an Introduction (the first chapter of the book), the second chapter describes in detail the main ideas in the calculus of variations (culminating in the study of Euler-Lagrange equations and second variation-based Legendre conditions) and seamlessly transitions to the treatment of the optimal control problems. The Hamiltonian function is introduced early on which subsequently features prominently in



the treatment of the Pontryagin's maximum principle. The end result of Chapter 2 is a solution to several types of optimal control problems (such as fixed end-time, with no control constraints) using the principles of the calculus of variations but stated in the formalism that will later be useful for more general optimal control problems. These developments are already sufficient for the in-depth treatment of Linear Quadratic Optimal Control problem for continuous-time systems, which is one of the central tools in the control theory. This treatment is a subject of Chapters 3 and 4 where the finite horizon and infinite horizon cases, set point and trajectory tracking, fixed-end point regulator system, Linear Quadratic Regulator with a specified degree of stability, and other topics are considered in detail. Frequency domain properties of the linear quadratic regulator are analyzed and the celebrated results on one half to infinity gain margin and 60 degrees phase margin are derived. Chapter 5 treats similar issues as in Chapters 2-4 but for discrete-time systems. In Chapter 6, the treatment of constrained control problems begins with the introduction of the Pontryagin maximum principle for these systems (using the notion of admissible variations) and dynamic programming techniques. The latter are also used to illustrate an alternative approach to deriving continuous-time and discrete-time linear quadratic regulator solutions. Time-optimal control problems are treated in Chapter 7 including the analysis of the number of switchings in the optimal ''bang-bang'' control laws for linear systems. Other special optimal control problems (*energy* and *fuel*-optimal control problems with integral costs) including the case of singular controls are touched upon as well. The developments are completed by considering the point wise-in-time state constraints and describing how they can be treated using either the penalty function method or the slack variable method. The appendices help make the book self-contained by reviewing some of the key results in linear algebra and state space analysis of linear systems, and by providing the listings of the relevant Matlab files (available electronically from the author).

The book is very readable and careful attention has certainly been given to provide the reader with a comprehensive set of tools without overburdening with the complex mathematical details and notations (although the key mathematical ideas are, indeed, well exposed and the logic underlying the developments is transparent and thorough). It should be accessible to a wide audience including graduate students and practitioners from engineering and other fields. *Optimal Control Systems* can be utilized both as a textbook in the introductory courses in the optimal control theory, or as a quick reference by practicing engineers. The use of Matlab/Simulink to treat the examples (including the snippets of the actual code), historical remarks about the scientists behind the major discoveries in the optimal control theory, recipe-style summaries of the key methodologies, exercise problems at the end of each of the chapters are undoubtedly the strong points of this book which significantly contribute to its pedagogical value.

On a somewhat more critical side, most of the examples in the book are, in fact, of relatively low order linear systems. This can actually be viewed as an advantage in that the in-depth treatment of these examples is possible so that the main ideas can be illustrated rather well. At the same time, the treatment of more of higher order nonlinear system examples in combination with a more extended introduction into the numerical methods of the optimal control could have been beneficial for the readers to gain an additional insight into how the underlying techniques can be applied.

IV. MECHANICS OF SOLIDS

1R7. Understanding Viscoelasticity: Basics of Rheology. - N Phan-Thien *(Mech Eng Dept, Natl Univ of Singapore, Singapore, 119260, Singapore).* Springer-Verlag, Berlin. 2002. 145 pp. ISBN 3-540-43395-3. $34.95.

Reviewed by YA Rossikhin (Dept of Theor Mech, Voronezh State Univ of Architec and Civil Eng, ul Kirova 3-75, Voronezh, 394018, Russia).

Understanding Viscoelasticity is one of the titles from the *Advanced Texts in Physics* series, which aims to provide a comprehensive and yet accessible introduction to a field at the forefront of modern research. This book presents an introduction to viscoelasticity with the emphasis on the theories of dilute polymer solutions and melts, and dilute suspensions of rigid particles in viscous and incompressible fluids. The book is based on the set of lectures delivered by the author as a one-semester course in viscoelasticity at the National University of Singapore, and it contains the necessary tools to understand viscoelasticity but does not insist on giving the latest information in the field.

The book involves 8 chapters, list of 52 references, index, one table, and 50 figures, among them 18 figures present photographs of the prominent scientists contributed significantly in the field. From the attached figure captions as well as footnotes, a student can read a brief biographical sketch of the researcher. To the reviewer's opinion, it is very useful for students to obtain some knowledge in the history of science and particularly in the history on mechanics.

This textbook starts with an introduction to the basic tools from tensor and dyadic analysis to be used thereafter. Non-Newtonian behavior in flows including the elasticity of a liquid and its ability to support large tension in stretching is discussed in Chapter 2. Kinematic properties and the equations of balance are presented in Chapter 3 both for small and finite strains. Basic principles and some classical constitutive equations are reviewed in Chapter 4. The simplest inelastic and linear viscoelastic models are discussed in Chapter 5. In Chapter 6, a special class of flows knows as viscometric flows, which is equivalent to the simple shearing flow, is specified. Chapter 7 concentrates on the constitutive modeling of dilute polymer solution within the microstructure approach. Chapter 8 is devoted to mechanics of suspensions, ie, effective fluids made up of parcels suspended in a liquid. A series of problems for student individual work ends each chapter.

Understanding Viscoelasticity: Basics of Rheology is intended for senior undergraduate and graduate students, who want to find an introduction to viscoelasticity, and thereafter the reviewer can recommend it for purchase by university libraries.

V. MECHANICS OF FLUIDS

1R8. Introduction to Symmetry Analysis. - BJ Cantwell *(Sch of Eng, Stanford Univ, Stanford CA 94305).* Cambridge UP, Cambridge, UK. 2002. 612 pp. Softcover, CD-Rom incl. ISBN 0-521-77740-2. $50.00. Also available in Hardcover ISBN 0-521-77183-8; $130.00.

Reviewed by TH Moulden (Dept of Aerospace Eng, Univ of Tennessee Space Inst, BH Goethert Pkwy, Tullahoma TN 37388-8897).

The application of Lie group theory is far from ubiquitous in engineering courses. Mathematics has of course, long been familiar with the topic (for example see such standard texts as PJ Oliver (1986), *Applications of Lie Groups to Differential Equations*, Springer-Verlag or PE Hydon (2000), *Symmetry Methods for Differential Equations*, Cambridge University Press). As such the text under review is a very welcome addition to the engineering literature and one that should be widely adopted. The book is intended for beginning graduate students in engineering and the applied sciences. The author notes that most problems of interest to those fields are nonlinear problems. The study of nonlinear problems requires all the tools that are available in order to obtain insight into the structure and properties of such physical situations. Closed form solutions are usually not available for such equations.

The book under review starts with a short chapter on the history of group theory and its applications to the subject at hand. A more detailed history here is IM Yaglon (1988), *Felix Klein and Sophus Lie*, Birkhauser, quoted by Cantwell as well as the more recent book T Hawkins (2000), *Emergence of the Theory of Lie Groups*, Springer-Verlag.

The first formal chapter introduces symmetry and the basic symmetry groups of interest in the remainder of the text. Some of these symmetries are continuous (as in the properties of homogeneity and isotropy characterized by translation and orthogonal groups) and some discrete (as associated with specific geometric objects). Since an important physical phenomenon is the breaking of a continuous translational symmetry into a discrete symmetry, both types of symmetry must be discussed. One of the classical tools in any engineering study is dimensional analysis and Chapter 2 is devoted to its application in selected problems. It is here that insight into the physics of the problem under study becomes essential. The text does a good job, throughout, of comparing the group methods with this dimensional analysis (Section 10.3 being an example) and other standard techniques.

Chapter 3 moves onto review the classical background from the theory of differential equations (both ordinary and partial) needed for the rest of the text. Of particular importance for certain applications is the study of *critical points* (Section 3.9) in the phase space of a dynamical system. The application in Section 13.6 to the local flow structures in turbulence being a case in point (ad makes contact with such work as that of AE Perry and MS Chong (1987), *A Description of Eddying Motions and Flow Patterns Using Critical Point Concepts*, Annual Review Fluid Mechanics, Vol 19, pp 125-155, as well as Cantwell's own work.

Chapter 4 treats classical dynamics mostly from the Hamiltonian viewpoint. This is mostly a review of classical material, along with examples, rather than a text on the subject. The cosmological two-body problem is treated in some detail.

One-parameter Lie groups are introduced in Chapter 5 while Chapter 6 applies this theory to first order ordinary differential equations. The Lie algebra of a Lie group (and its importance) is introduced in Chapter 5. Thus, in local kinematics the Lie algebra SO_3 associated with the spin tensor maps (via the exponential function) to the Lie group SO_3; thus relating vorticity to fluid rotation. The reader may find that more background in Lie theory is required beyond what is provided by the text. Previous familiarity with algebra would be of utility, at this point, to provide background to some of the algebraic structures needed (the classic: IN Herstein (1975), *Topic in Algebra*, Wiley, would serve here and the recent text: A Baker (2002), *Matrix Groups*, Springer-Verlag, also provides some mathematical structure for special cases).

After an introduction of the notation for differential functions in Chapter 7, Chapter 8 treats ordinary differential equations of higher order from the Lie viewpoint while Chapter 9 extends this to partial differential equations. Higher order differential equations can be treated by means of successive reductions of order.

The middle section of the book (Chapters 1-13) applies the techniques developed in the early chapters of the book to problems in fluid mechanics. Chapter 10 addresses the classical boundary layer theory, Chapter 11, incompressible flows in general, Chapter 12 compressible in viscid flows, and Chapter 13 the turbulent shear flow. The boundary layer concept in fluid mechanics is about 100 years old now and Prandtl's equations have been an essential feature of aerodynamics for much of that time. The advent of numerical solution techniques for the full Navier-Stokes equations has reduced this role, in a practical sense, but the conceptual ideas are still very relevant. The text first develops the classical Blasius equation and notes its invariance under the dilation group in order to extract a similarity solution. The other classical similarity solution the Falkner-Skan equation is also discussed.

Chapter 11 moves to the full incompressible flow Navier-Stokes equations. One of the early applications of Lie concepts to fluid mechanics was with these equations (RE Boisvert, WF Ames, and UN Srivastava (1983), *Group Properties and New Solutions of the Navier-Stokes Equations*, J Eng Math, Vol 17, pp 203-221). Ames has done much to promote symmetry analysis (acting, as he did, as editor for the translation of the important text LV Ovsiannikov (1982), *Group Analysis of Differential Equations*, Academic Press). The problems associated with unsteady jets flows are discussed in detail in this chapter.

A study of compressible flows form the subject of Chapter 12 with attention restricted to in viscid flows. This restriction is not significant for most of the problems discussed (spherical blast waves and similarity for airfoil flows, for example). The transonic flow similarity condition being an exception in the flow over thin airfoils since shock induced boundary layer separation (breaking the similarity) cannot be considered under this restriction.

Those with an interest in fluid turbulence will turn to the 50 pages of Chapter 13 to read about similarity rules in turbulent shear flows. Turbulence models are not discussed (but page 399 does make note of symmetry analysis as an *extremely useful tool* for the development of rational models of turbulence: no reference is given however). Section 13.6 contains the important analysis of the fine scale dissipation motions and their geometric structures. This is done by studying the invariants of the velocity gradient tensor. Not surprising is the finding that vortical structures play a dominant role. The important Galilean invariance constraint on turbulence models is not mentioned, however.

The remainder of the text (Chapters 14-16) is devoted to the Lie-Bäcklund transformations and their uses. These, as distinct from the Lie point transformations discussed in the earlier chapters, are contact transformations. Thus Chapter 14 introduces the transformations and their basic properties along with some examples; in particular the Blasius equation is discussed and compared with the earlier treatment of that equation in Chapter 8. Chapter 15 discusses various symmetries and conservation laws and the corresponding Lie-Bäcklund groups. Chapter 16 extends the discussion to include the non-local groups.

The text ends with three appendences dealing with background mathematical material with the first appendix devoted to basic calculus and the theory of contact. The need for a clear notation, to avoid confusion, is pointed out here. The second appendix deals with the invariance of contact conditions under Lie transformations while the third considers the Lie-Bäcklund transformations.

The important physical phenomena that lead to symmetry breaking (from, for example, continuous to discrete symmetry or via a Hopf bifurcation) are not a prominent feature of the text. This does limit the utility of the book as a reference while not harming its primary mission.

About the book in general: there are some meaningful exercises at the end of each chapter as well as a representative list. The book comes with a CD containing software for *Mathematica*®, which greatly assists the mechanics of finding Lie symmetry groups. Appendix 4 discusses this software. The text does warn, however, that this process can take much computer memory and a lot of processing time. It is best to approach this book with pen and paper in hand to work through the details and have the CD close by to use as appropriate. Very few typographical errors were noted. Other texts of interest for the basic Lie theory (but not the detailed applications in the text under review) include (in addition to texts mentioned above): GW Bluman and S Kumei (1989), *Transformations of Manifolds and Applications to Differential Equations*, Longman, while Cantwell makes frequent reference to NH Ibragimov (1994), *CRC Handbook of Lie Group Analysis of Differential Equations*, CRC Press.

Introduction to Symmetry Analysis is nicely presented by Cambridge University Press in its *Cambridge Texts in Applied Mechanics* series. It should find a wide audience in the engineering and applied sciences community and we wish it well.

1R9. Plasma and Fluid Turbulence: Theory and Modelling. Series in Plasma Physics. - A Yoshizawa *(Inst of Indust Sci, Univ of Tokyo, Japan)*, S-I Itoh *(Res Inst for Appl Mech, Kyushu Univ, Japan)*, K Itoh *(Natl Inst for Fusion Sci, Toki, Japan)*. Inst Phys Publ, Bristol, UK. 2003. 459 pp. ISBN 0-7503-0871-0. $135.00.

Reviewed by Toshi Tajima (Kansai Res Est, JAERI, 8-1 Umemidai, Kizu, Kyoto, 619-0215, Japan).

This book is a good reference book for researchers on complex phenomena of turbulence that determine the major aspect of the fundamental behavior of many plasmas and fluids. The first author is an expert in fluid mechanics, while the latter two are specialist in fusion plasmas. This book takes statistical mechanical viewpoints into account to the extent reasonable to the subject of turbulence. This way the authors consciously try to broaden the field that they embarked on, which seems to be one of the book's objectives. In particular the book details on the nonlinear behavior of plasmas and fluids that exhibit the phenomenon of hysteresis. These chapters (Chs 16, 19, 22-25) are based on the authors' own frontier research and show their depth and connect to a broader discipline of nonlinear science (and once popular mathematical field of *catastrophe theory*), yielding the flavor and appeal central to this book. It would have been even more powerful, if the authors had more deeply incorporated the strong Russian school of nonlinear applied mathematics and science, such as the works of *Nonlinear Oscillations* (Lefschetz), *Fluid Mechanics* (Landau-Lifshitz), and those by Ginzburg, that lay some of the important cornerstones of nonlinear science. (Ginzburg-Landau's nonlinear potential alone spawned out many important ideas in physics such as superconductivity theory and Higgs bosons as well as the bifurcation theory.)

In fact, broader references are desired for this book, that I suppose, tries to bury gaps among several fields, including fluid turbulence plasma turbulence, statistical mechanics, chaos theory, nonlinear science, and astrophysics, which all embrace states far from equilibrium. Some of the more important references that the reader have get benefit from, if cited, include:

— Parker's reference on his first paper on dynamo and a book by Krueger on the same topic (on the mean filed theory of dynamo) (Chs 6 and 10),

— Transport coefficients and their symmetry by Onsager (Chs 12 and 25),

— Geometry influence such as the toroidicity on the stability and transport of plasmas pioneered by Chen, Kishimoto and others (Chs 17 and 18). One of the most spectacular examples of progress in recent times in plasma theory is that it has gained predictive capacity in the description of kinetic behavior. This originates from the ability to incorporate global geometrical effects such as the toroidicity even for microscopic kinetic modes.

— First paper on ionizational bifurcation by Drane and Sutin (1987) relevant to the later L-H transition the authors discuss (Ch 22), disk oscillations/bifurcations in astrophysical plasmas (Mineshige) (Chs 16 and 22), for example.

It was a bit sobering to learn that the theory of turbulence has not progressed much since the reviewer's student time, when theories of Heisenberg and Kolmogorov were the fundamental literature. However, some treatments of the renormalization group theoretic approach and the Pade approximation in turbulence (Chs 14 and 16) have educated this reviewer. Insights into turbulence derived from computer simulation should be among the new sections to this difficult and age-old subject. Turbulence behavior not touched by classical turbulence theory that has been recently studied includes fractal structures, intermittence, and kurtosis. The reviewer would like to see some discussion like these at the level of this book. In spite of these complaints, *Plasma and Fluid Turbulence* has succeeded in its difficult mission to explain themes of the authors weaving through esoteric subjects of numerous plasma instabilities.

VI. HEAT TRANSFER

1R10. Nonclassical Thermoelastic Problems in Nonlinear Dynamics of Shells. Applications of the Bubnov-Galerkin and Finite Difference Numerical Methods. - J Awrejcewicz *(Dept of Automatics and Biomechanics, Tech Univ of Lodz, 1/15 Stefanowskiego St, Lodz, 90-924, Poland)* and VA Krys'ko *(Dept of Math, Saratov State Tech Univ, 77 Polyteshnycheskaya St, Saratov, 41005, Russia).* Springer-Verlag, Berlin. 2003. 428 pp. ISBN 3-540-43880-7. $89.95.

Reviewed by MV Shitikova (Dept of Struct Mech, Voronezh State Univ of Architec and Civil Eng, ul Kirova 3-75, Voronezh, 394018, Russia).

Nonclassical Thermoelastic Problems in Nonlinear Dynamics of Shells is one of the latest titles from the *Scientific Computation* series published by Springer-Verlag. This monograph describes some approaches to the linear and nonlinear dynamic theory of thermoelastic plates and shells. By nonclassical problems the authors mean the problems described by two and three-dimensional differential equations of hyperbolic and parabolic type, in so doing the interaction between the strain and temperature fields is taken into account. When solving nonlinear problems, both physical and geometrical nonlinearities are considered.

The book involves 9 chapters, 247 references, a subject index, 21 tables, and 222 figures. Chapter 1 presents a brief review of the literature devoted to the dynamic coupled thermoelastic problems, in so doing the emphasis is made to Eastern references published in Polish and Russian, which can be of great interest to a Western reader. Since there exists a very large number of books, papers and commercial software packages devoted to application of different numerical methods for the analysis of plates and shells, the authors restrict their efforts to the Ritz method and the Bubnov-Galerkin method, resulting only in mathematical and numerical investigations of some specific problems related to the coupled theory of elastic and elasto-plastic plates and shells.

Chapter 2 presents the basics of the coupled linear thermoelasticity of shallow shells modeled by both the Timoshenko and Kirchhoff-Love theories. The existence and uniqueness of a general solution are discussed. The authors have not introduced any limitations on the temperature distribution through the shell thickness; therefore, the temperature depends on the three spatial coordinates and the time, while the components of the displacement vector of a point of the middle surface of the shell depend on the two spatial coordinates and the time, resulting in a set of equations of different types (hyperbolic and parabolic ones) with different dimensions. The second part of Chapter 2 is focused on the dynamics of an elastic infinite cylindrical panel within a transonic gas flow. Free and forced panel vibrations are analyzed using the finite-difference method. The stability loss of the panel within a transonic flow is investigated.

Chapter 3 discusses estimation of the errors of the Bubnov-Galerkin method applied for solving a system of linear differential equations, which corresponds to coupled thermoelastic problems for plates and shallow shells with variable thickness.

Numerical investigations of the errors of the Bubnov-Galerkin method are given in Chapter 4 for the following problems: vibration of a transversely loaded simply supported square plate without a thermal load, the vibrations of a simply supported plate with a given initial distribution of deflection or of its velocity with neither a mechanical nor a thermal load.

Fundamental assumptions and relations for coupled nonlinear thermoelastic problems and the equations describing vibration of a Timoshenko-type shell are formulated in Chapter 5. The existence and uniqueness of a solution of some initial-boundary value problems of coupled thermoelasticity as well as the convergence of the Bubnov-Galerkin method are discussed.

Theory of Kirchhoff-Love type shallow shells with physical nonlinearities in the form of small elasto-plastic deformations and coupling of temperature and strain fields is developed in Chapter 6.

Chapters 7 and 8 are devoted to the numerical solution of some nonlinear problems described by the hybrid form of the differential equations obtained in Chapters 5 and 6. Numerical procedures based on the finite-difference method and the relaxation method are presented for the analysis of the vibration of an isolated shell subjected to an impulse load which is constant in time and uniformly distributed, for the dynamic stability of shells under thermal shock, as well as for the analysis of the regular and chaotic behavior of the plate. Vibrations and stability of elasto-plastic shells subjected to cyclic loading are discussed within the theory of small elastic-plastic deformations.

Some nonlinear dynamic problems of thermoelastic shells to be solved by the authors in the nearest future are outlined in Chapter 9.

In this book, despite of traditional approach, when the heat transfer equation is reduced to the two-dimensional form by integrating over the shell thickness, the three-dimensional heat transfer equation is used. The utility of using the two-dimensional equations of shell motion and the three-dimensional heat transfer equation taking the coupling between the train and temperature fields is not apparent to the reviewer's opinion, since in the expansions of shell displacements in terms of the shell thickness the terms of the zero and first orders are held, thereafter the temperature terms of the orders larger than the first entering into the equations of motion should be discarded, since they have the order higher than the other terms of equations.

The book is well written and involves a large amount of good quality figures illustrating numerical examples. The reviewer could recommend this monograph for using in graduate student courses devoted to the shell theory and for purchase by the university libraries. It also could be of interest for graduate students, researchers and practical engineers dealing with numerical investigation of thermomechanical behavior of plates and shallow shells.