BOOK REVIEWS

I. FOUNDATIONS & BASIC METHODS

11R1. Computational Partial Differential Equations: Numerical Methods and Diffpack Programming, Second Edition. - HP Langtangen *(Simula Res Lab, Martin Linges vei 17, Fornebu, PO Box 134, Lysaker, 1325, Norway)*. Springer-Verlag, Berlin. 2003. 855 pp. ISBN 3-540-43416-X. $69.95.

Reviewed by RL Huston (Dept of Mech, Indust, and Nucl Eng, Univ of Cincinnati, PO Box 210072, Cincinnati OH 45221-0072).

This is the second edition of a popular tutorial on the numerical solution of partial differential equations (PDEs). It is intended for students, researchers, and practitioners interested in developing computer codes for the solution of the equations. The stated aim of the book is to equip the reader with skills for developing simulation software for physical phenomena (particularly, solid and fluid mechanics) governed by PDEs.

The flow and style of the book are numeric together with listed computer codes. The software tools are based upon Diffpack–a numerical library using C^{++} and object oriented modules. Prior familiarity with C^{++} and Diffpack is thus obviously an advantage for potential readers. However, the book is written so that readers can learn both C^{++} and the use of Diffpack through a series of simple introductory examples and illustrations.

The book is directed toward application in the various areas of solid and fluid mechanics.

The book itself is divided into seven large chapters (or sections) together with four appendices spanning over 800 pages. Chapter 1 introduces the concepts of PDE solution using Diffpack. Elements of C^{++} programming are included. The chapter presents several illustrations of finite difference solution of the Poisson equation and the wave equation.

Chapter 2 provides an introduction to the finite-element method starting with a discussion of weighted-residual methods and concluding with the mathematics of variational formulations.

The third chapter presents a discussion of the use of Diffpack's finite element software tools. Applications in heat transfer and the solution of the wave equation are given.

Chapter 4 is devoted to nonlinear problems. It discusses discretation and the solution of nonlinear PDEs using both finite-difference and finite-element methods.

Chapter 5, 6, and 7 present applications in solid mechanics, fluid mechanics, and coupled solid/fluid and fluid/heat transfer problems.

The book concludes with four appendices providing extensive discussions of the underlying mathematics, Diffpack topics, linear systems, and software tools for solving linear systems.

In the spirit of being a tutorial and text, *Computational Partial Differential Equations: Numerical Methods and Diffpack Programming* has over 150 exercises and a comparable number of worked-out examples together with computational code. There is an extensive bibliography of 156 references for further reading.

The book is clearly very specialized but still devoted to an important aspect of applied mechanics. Therefore, it should be of interest and use to researchers and practitioners working in computational mechanics and to students aspiring to enter that field. It should make a good text for graduate-level numeric courses. Purchase by libraries is recommended.

11R2. Numerical Modeling in Materials Science and Engineering. Series in Computational Math, Vol 32. - M Rappaz *(Lab of Phys Metall, Swiss Fed Inst of Tech, Lausanne, 1015, Switzerland)*, M Bellet *(Ecole des Mines de Paris, CEMEF, Sophia Antipolis, 06904, France)*, M Deville *(Lab of Comput Eng, Swiss Fed Inst of Tech, Lausanne, 1015, Switzerland)*. Springer-Verlag, Berlin. 2003. 540 pp. ISBN 3-540-42676-0. $89.95.

Reviewed by HM Srivastava (Dept of Math and Stat, Univ of Victoria, PO Box 3045, Victoria V8W 3P4, BC, Canada).

The past two decades have witnessed an increasingly diversified account of the various numerical methods and their applications in the fields of materials science and engineering; in particular, the Monte Carlo methods, cellular automata, random walkers, atomistic methods related to molecular dynamics, boundary element methods, homogenization techniques based upon average conservation laws, and so on. The book under review is devoted to the numerical simulation and modeling in (especially) materials science and engineering. It aims at familiarizing the materials scientists and engineers with the numerical methods and techniques that are state-of-the-art in this subject.

There are ten chapters in this book. Chapter 1 (Continuous Media) introduces the equations of conservation of mass, momentum, energy and solute, initiates an investigation of the principal equations for materials behavior (which are developed in depth in Chapters 5, 6, and 7), and provides the definitions of the boundary conditions and the initial conditions. And the last chapter (Chapter 10, Appendices) consists of the sections Table of Symbols, Vector Calculus, Gauss Integration Method, Non-Dimensional Numbers, and Interpretation of the Terms of the Elementary Stiffness Matrix for a Diffusion Problem on a Triangular Linear Finite Element.

Chapter 2 (The Finite Difference Method), Chapter 3 (The Finite Element Method), and Chapter 4 (Elements of Numerical Algorithms) present lucid and more-or-less self-contained accounts of the subjects titled and also indicate the possibility of extending some of these methods to sundry more complicated cases which are not dealt with in detail in this book.

Chapter 5 (Phase Transformations), Chapter 6 (Deformations of Solids), and Chapter 7 (Incompressible Fluid Flow) provide further in-depth developments of the aforementioned principal equations for materials behavior (which were introduced in Chapter 1 itself).

The remaining chapters of this book, Chapter 8 (Inverse Methods) and Chapter 9 (Stochastic Methods) describe and illustrate the underlying general principles of each of these additional methods.

With the natural exception of Chapter 10, each chapter of this book contains a bibliography for further reading. And, more importantly, *Numerical Modeling in Materials Science and Engineering* is full of useful computer-generated pictures and diagrams for illustrative purposes.

In summary, this is a well written and well-organized reference book that will hopefully prove to be indispensable, especially for those materials scientists and engineers whose investigations make use of the various numerical methods and techniques developed in this book.

11R3. Perturbation Methods for Differential Equations. - BK Shivamoggi *(Dept of Math, Univ of Central Florida, Orlando FL 32816-1364)*. Birkhauser Boston, Cambridge MA. 2003. 354 pp. ISBN 0-8176-4189-0. $59.95.

Reviewed by J Awrejcewicz (Dept of Autom and Biomech, Tech Univ of Lodz, 1/15 Stefanowskiego St, Lodz, 90-924, Poland).

This book is focused on perturbation methods mainly applied to solve both ordinary and partial differential equations, as its title implies. As explained by the author, one of the unusual features of the treatment is motivated by his lecture notes devoted to a mix of students in applied mathematics, physics and engineering. Therefore, it is intended to serve as a textbook for both undergraduale students of the previously mentioned branches of science. However, I wonder if the students will be able to understand fully physical aspects of many various examples of completely separated fields such as solid mechanics, fluid dynamics and plasma physics. This aspect has been probably understood by the author, who added many appendices to the chapters. On the other hand, looking for the cited 26 references authored or co-authored by BK Shivamoggi, it is not surprising that his research covers the above-mentioned branches of science. This book can serve also as an example how an asymptotic analysis may easily move between various different disciplines.

The book is 354 pages long and has 130 references. It is divided into seven chapters.

Chapter 1 introduces a reader with asymptotic series and expansions of some arbitrarily chosen functions. It can be treated as a brief panoramic picture to the further problems dealt with the book.

In Chapter 2 regular perturbation methods are addressed. First algebraic equations are considered (four examples), then differential equations are analyzed (four examples), and finally partial differential equations are studied (1 example). The author originally introduced some of the outlined examples (for example, Section 2.5 is devoted to aplication to fluid dynamics published already by the author in 1998) and some were taken from other cited sources. Eight exercises are given at the end of this chapter to be solved by a reader or student.

In Chapter 3 the method of strained coordinates (parameters) is described. In Section 3.2, the Poincaré-Lindteadt-Lighthill method of perturbed eigenvalues is briefly stated with the supplement three examples. In addition, the eigenfunction expansion method (Section 3.3), Lighthill's method of shifting singularities (Section 3.4), and the Pritulo's method of renormalization (Section 3.5) are presented with supporting examples. It is worth noticing that the applications come from various fields including wave propagation in a homogeneous medium, nonlinear buckling of elastic columns, and a few examples within the field of fluid dynamics and plasma physics. The main limitation of the strained coordinates method, ie, an incapability of determining transient responses of dissipative systems, is illustrated and discussed. Nine exercises are added for the reader to solve.

Chapter 4 discusses the method of averaging. After a brief introduction, the Krylov-Bogoliubov method of averaging is described and two classical examples adopted from the Nayfeh work are given. Section 4.3 includes one sentence describing the so called generalized Krylov-Bogoliubov-Mitropolski method, and then two classical examples of the Duffing and van der Pol oscillators are considered. Witham's average Lagrangian method is addressed in Section 4.4 using a nonlinear dispersive wave propagation problem. In the next section the Hamiltonian perturbation method is introduced followed by three examples. Then the averaged Lagrangian method is applied to study a nonlinear evolution of a modulated gravity wave packet on the surface of a fluid. At the end of the chapter, seven exercises are included.

The method of matched asymptotic expansions is described in Chapter 5. After a brief introduction and physical motivation the method of matched asymptotic expansion is explained through a simple example by computing inner, outer, and composite expansions. Applying Cole (1968) and Keviorkian and Cole (1996) results, the linear hyperbolic partial differential equation is analyzed in Section 5.4, the elliptic equations are described in section 5.5, and the parabolic equations are analyzed in Section 5.6. The interior layers are illustrated in Section 5.7 using an example introduced earlier by Lagerstrom (1988). In Section 5.8 Latta's (1951) method of composite expansions are illustrated via three examples (two of them are borrowed form Nayfeh (1973) and Keller (1968)).

Section 5.9 titled *Turning-point problems*, includes a description of the JWKB approximation [with two examples borrowed from Holmes (1995)], the solution near the turning point and the Langer's method. An application of the matched asymptotic expansion is taken from the field of fluid dynamics. Namely, a boundary layer flow past a flat plate is studied. Next, ten exercises to be solved follow. A method of multiple scales is illustrated in Chapter 6. After a brief introduction to the method, the differential equations with constant coefficients are addressed in Section 6.2, where eight examples are included (six of them are borrowed form other references). Struble's method is described in Section 6.3, where two examples are given. In Section 6.4 differential equations with slowly varying coefficients are considered. Two supplemented examples illustrate application of the multiple scale method. The generalized multiple scale method, following Nayfeh (1964), is presented via two boundary-value problems. The considered applications include dynamic buckling of a thin elastic plate (solid mechanics) and a few examples taken from fields of fluid dynamics and plasma physics. The chapter finishes with eleven examples to be solved.

The last chapter, 7, is devoted to miscellaneous perturbation method. The main purpose of this chapter is to describe some special perturbation techniques that are very useful in some applications. The series of discussed methods include a quantum-field-theoretic perturbative procedure and a perturbation method for linear stochastic differential equations. Four exercises to be solved are given at the end of this chapter.

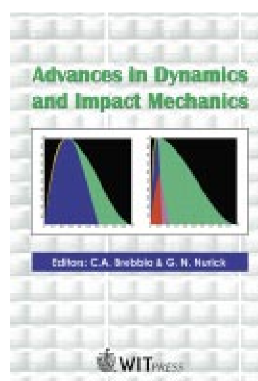
Since *Perturbation Methods for Differential Equations* covers a great deal of material, it is recommended to students and researchers, already familiar with solid and fluid mechanics, as well as with plasma physics. In general the figures and tables are fine, and the index is adequate, hence I recommend the book to be purchased by both individuals and libraries.

II. DYNAMICS & VIBRATION

11R4. Advances in Dynamics and Impact Mechanics. - Edited by CA Brebbia *(Wessex Inst of Tech, UK)* and GN Nurick *(Univ of Cape Town, S Africa)*. WIT Press, Southampton, UK. Distributed in USA by Comput Mech, Billerica MA. 2003. 293 pp. ISBN 1-85312-928-3. $165.00.

Reviewed by AE Bogdanovich (3TEX Inc, 109 MacKenan Dr, Cary NC 27511).

This collection of eleven papers written by different authors from Bulgaria, India, Poland, Denmark, Greece, Portugal, United Kingdom, Norway, Japan, and Hong Kong is unified by the topics of advanced dynamic modeling, analysis, and experimental characterization of metallic, composite, and concrete structures. The book can be of significant interest for researchers, engineers, and graduate-level students who work in the areas of structural dynamics, computational mechanics, solid mechanics, finite element analysis, crashworthiness, impact, stress wave propagation, dynamic buckling, failure and damage analysis, and experimental dynamics. Specialists in composite materials, reinforced concrete, and sandwich structures can also find useful information in some chapters of the book.



Specific topics addressed in the book include:

Dynamic elastic-plastic buckling of metal tubes having circular and square cross-sections.

Axisymmetric plastic deformation and buckling of cylindrical metal tubes.

Crushing analysis of ship structures.

Crushing under impact of composite sandwich structures with unconventional (*corrugated* and *tubular*) cores.

Dynamic crashworthiness analysis of multi-body systems.

Progressive collapse simulation of polymeric composite sandwich beams.

Dynamic analysis of square plates under blast loading.

Ballistic penetration and perforation of relatively thick steel plates.

Dynamic analysis of large-scale civil engineering structures under low-velocity impact.

Dynamic deformation and failure analysis of a free-flying beam hit by a deformable projectile.

Deformation and failure analysis of prestressed concrete beams under impact loading.

Importantly, the presented analytical and numerical studies are supported, in most of the book chapters, by appropriate experimental work, which is primarily aimed at verification and validation of the obtained numerical results. At the same time, many of the presented experimental results are of substantial independent interest.

Among the most popular analysis tools implemented in many chapters of this book are commercial codes LS-DYNA and ABAQUS (explicit and implicit). Some of the authors used MSC. Dytran, specialized code DAMAGE and other specialty analysis programs. It is worth emphasizing that the performed finite element analysis studies addressed mainly complex, two-dimensional and three-dimensional problems. A lot of attention is paid in the book to the development and implementation of advanced material models and evaluation of their adequacy to the actual dynamic behavior of metals and other materials of interest. Numerical results, experimental data, and their mutual comparison provide valuable information for practical applications and future research studies. The quality of illustrations and tables is good, overall.

Along with insightful studies of specific theoretical and experimental problems, the book provides an excellent overview of recent accomplishments in structural dynamics and impact mechanics. Part of the book's present results has already been published in journal articles and conference papers, while another part contains previously unpublished information. In either case, collecting under one cover eleven high-quality articles devoted to a number of modern, complex, and practically important structural dynamics problems was a worthwhile idea realized into a very useful book.

One significant deficiency of *Advances in Dynamics and Impact Mechanics* is that it does not have a subject or author index. Also, a unified summary of the presented research efforts and some recommendations for future research, written by the book editors, would give a better conclusion of the book.

Without reservation this reviewer recommends that this book should be purchased by libraries and also by those individuals whose work and/or education is related to theoretical and experimental studies of various engineering materials and structures exposed to impact and other types of dynamic loading.

11R5. Dynamics of Synchronising Systems. - RF Nagaev *(Dachny pr 9-2-66, St Petersburg, 198255, Russia)*. Springer-Verlag, Berlin. 2003. 326 pp. ISBN 3-540-44195-6. $149.00.

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

This book is a monograph on the use of the averaging technique for solving the problems of theoretical, quantum and applied mechanics.

The book is aimed at both graduate and postgraduate students as well as researchers in mechanics and physics with university or equivalent education. It is assumed that the reader has a basic knowledge of analytical mechanics, theory of nonlinear oscillations, rigid-body dynamics, quantum mechanics and electrical engineering, as well as of mathematics in the framework of a basic course taught at a technical university.

The book is divided into 11 chapters.

Chapter 1 is devoted to the concept of local integrability and consideration of possibilities of the choice of small parameters.

Chapter 2 contains a brief description of mechanical and electromechanical systems that can be considered as being conservative.

In Chapter 3 and 4 the single-and multivariable systems in ''action-angle'' variables are analyzed.

In Chapter 5 multifrequency averaging of the system with a multidimensional rapidly rotating phase is carried out by a modified averaging procedure.

Usage of canonical averaging of the equations of quantum mechanics, in particular the Schrödinger's equation with various potentials, made it possible to obtain a solution in a more appropriate form than on the basis of the spectral analysis (Chapter 6).

In Chapters 7, 8, and 10 the problems of weak interactions of quasiconservative dynamic systems are studied. Interesting effects of synchronization are discovered and studied.

Periodic solutions in problems of excitation of mechanical oscillations form the subject of Chapter 11.

It is noteworthy that all solutions obtained are valid for finite, but relatively extended time intervals.

The book is very interesting from the standpoint of practically usable important results as well as for further development of averaging procedure. The subject index is informative, but somewhat short. The quality of the figures is high, but, unfortunately, no captions are included. References contain mainly papers and books written in Russian, just as Russian books now have been translated into English. Moreover, practically all-Russian journals referred to are cover-to-cover translated into English. For example, MTT is translated as Mechanics of Solids, PMM as PMM J Appl Math Mech, etc. It may therefore be more natural and convenient for readers to refer to English translations.

This skillfully written book is a reader-friendly and well-organized textbook in the field of mathematical mechanics. As a rule, each section includes a pedagogical introduction.

Dynamics of Synchronising Systems is highly recommended for purchase by both individuals and libraries.

11R6. Essays on the Motion of Celestial Bodies. - VV Beletsky *(Keldysh Inst of Appl Math, Russian Acad of Sci, Miusskaja Sq 4, Moscow, 125047, Russia)*. Birkhauser Verlag AG, Basel, Switzerland. 2001. 372 pp. ISBN 3-7643-5866-1. $169.00.

Reviewed by FH Lutze (Dept of Aerospace and Ocean Eng, VPI, Blacksburg VA 24061-0203).

These ''Essays'' are the second edition of a publication that first appeared in Russia in 1972.

The first edition was reprinted in four different languages, the last one appearing in French in 1986. Since that time, a considerable amount of material has been added to the work, leading to a second edition that appeared in 1999. The English version was published in 2001 and is the subject of this review. Readers who have worked in the area of celestial mechanics and artificial satellite motion will be quite familiar with the name VV Beletsky and the quality of the work that he has produced. His classic work on the ''Motion of an Artificial Satellite About its Center of Mass'' (NASA-TT-F-429, TT-67-51366, 1967) and with EM Levine the work ''Dynamics of Space Tether Systems'' (Advances in the Astronautical Sciences, Vol 83, 1993) are indicative of the thoroughness and delightful writing style that is characteristic of his work. The essay in this volume are written in a more informal manner and convey the joy and passion that the author has for his work.

As stated by the author in the preface, the one major feature in common for the problems discussed is that they are all interesting. The problems discussed range from fun problems to important ones, and from old well-known problems to new problems of current interest. In each case, care and preciseness associated with this author prevails. However, do not be misled into thinking that these essays are just derivations of old and new results. On the contrary, these essays present results with little derivation, relying on references to provide the details. It allows the reader, under the tutelage of a seasoned dynamicist, to step back and look at the problem from various viewpoints, without getting lost in the details. One of the objectives of these essays as stated in the preface is to ''help its readers become aware, even to a small extent, of how astonishing and rich in events and phenomena the mechanics of space flight is.'' It is this reviewer's opinion that this goal is met.

It will be impossible to give each essay its justice. The titles of each essay sound quite routine and do not reflect the complete story of what is presented. Here we will look at a few of the essays to try and give the flavor of this book. Each essay starts with a quote. The quote for the first essay is ''Dear Fagot, show us something simple for the start.'' M Bulgakov, *The Master and Margarita*. The title of the first essay is ''On the Unperturbed and Perturbed Motion of a Satellite, with a Digression on Asymptotic Methods of Nonlinear Mechanics.'' It essentially covers the material in a first-level graduate astrodynamics course. One of the first points that is made is that we are ''lucky'' that we only have a single star system rather than a multiple star system where integrating the equations of motion might not be so easy! The second essay, ''On the Rebirth of an Old Problem, or what Happens if two Masses are Placed at a Purely Imaginary Distance from one Another,'' starts with the quote '' . . . and the more he looked at the bell-rope, the more he felt that he had seen something like it, somewhere else, sometime before.'' *AA Milne, The World of Pooh*. The essay deals with the problem of the motion of a particle about two fixed Newtonian centers. He writes the equations of motion, expands them, and compares the resulting terms with those of a nonspherical earth that were presented in essay one. He then proceeds to introduce several ways to attack the problem and adds much insight from experience.

The third essay is titled ''Yet Another Reincarnation of an Old Problem'' and discusses the solution to the problem of motion in an inverse square gravitational field with an additional constant force in a constant direction. Some of the results presented are very unexpected. The fourth essay, ''The Motion of the Worlds,'' discusses resonances in the solar system and its stability. In this essay a conjecture by AM Molchanov is presented that says, ''Oscillating systems that have reached evolutionary maturity are unavoidably resonant, and their structure is given by a set of integers.'' There is also an interesting section that indicates that if the moon had a high inclination, say 90°, it would have fallen into the Earth. The fifth essay deals with the three-body problem, patched conics and galaxy models. The sixth essay is the longest and is titled ''They are Waltzing in Orbits.'' This essay is the longest and reflects a lot of the work done by Beletsky on the motion satellites about their mass centers. Included are Moon-Earth, Mercury-Sun motions in 1:1 and 3:2 rotational resonances, respectively. In addition there is further discussion on stability and magnetic torques acting on satellites. The seventh essay, ''A Spiral to Space,'' deals with low thrust problems and spiral escape from the earth. The eighth essay is ''The Full Force of the Sun Blows in the Sails,'' and looks at the solar sailing problem, comparing some analytical results with AC Clark's science fiction story, ''The Wind From the Sun.'' The ninth essay, ''The Gravity Flyer,'' is one of the more ''off the wall'' essays. Because a finite-size spaceship's center of gravity is not located in the same orbit as it would be if all the mass were concentrated at one point, energy can be pumped into the orbit by pulsing the spaceship from a point to its full deployment and back again with the appropriate period. By so doing, you can eventually escape the attracting body. Of interest here is a full reporting of comments on this idea by various scientists, some of which indicated Beletsky's ideas were '' . . . based simply on ignorance... .'' The tenth essay, ''Interplanetary Flights: Low Thrusts for High Goals,'' considered low-thrust interplanetary orbits for which optimization of the thrust direction takes an important role. The eleventh essay, ''Relative Motion of Orbiting Bodies,'' deals with a problem that is of current interest with regard to formation flying. In addition he looks at a version of the problem of two satellites attached with a tether. Also included is an analysis of a particle cloud. The final essay is ''Cosmic Pinwheel.'' It discusses and explains the motion of the Proton satellites that had solar panels fixed like a pinwheel about the axis of the satellite. This caused the satellite to spin up or spin down, causing unusual attitude behavior that was observed first, and then explained by applying basic physics.

Essay on the Motion of Celestial Bodies is extremely well written, although there are a few problems in the translation, they do not interfere with the spirit of the author. The technical figures are excellent and in addition there are several cartoon like figures in each essay reflecting the basic idea of the essay. It would help a lot if the reader has a solid background in space mechanics, although the author claims it is not necessary. The beauty of the book and the treatment of the subject would be missed by a general reader. This is not a textbook; nor is it a reference book, it is just a fun book to read that will give the reader new ways to think about old problems and some new ideas for attacking more recent problems of interest. Each essay has its own set of references and the book has a complete list of referenced authors with the page(s) on which they are referenced. Many of the references are from the Russian literature, so it provides a good review of work done in that country in the 1960s and 1970s. I would strongly recommend this book, as an addition to one's library, although I think the price will discourage most people ($170) from purchasing it.

11R7. Modern Approach to Classical Mechanics. - H Iro *(Inst for Theor Phys, Johannes Kepler Univ, Linz, Austria)*. World Sci Publ, Singapore. Distributed in USA by World Sci Publ, River Edge NJ. 2002. 442 pp. ISBN 981-238-213-5. $58.00.

Reviewed by K Anderson (Dept of Mech Eng, Aeronaut Eng, and Mech (JEC4006), RPI, Troy NY 12180-3590).

The book covers virtually all aspects of the field of classical mechanics starting from Newton's laws of motion for the motion of a point mass. The book progresses to the concepts of integrals of Newton's equations of motion, which leads naturally to the concepts of energy and the potential for constants of motion such as with conservation of energy, and angular momentum. The author provides some interesting discussion of specific cases and diverges from most traditional texts with his presentation of the notion of chaos, phase space analysis, and stability analysis very early in the book. All the common subjects (central force motion, two-body gravitational problem, restricted three-body problem, simple oscillators, damped oscillators, particle collisions, and the like) are presented, as are the more advanced treatments such as Lagrangian mechanics, rigid bodies, Hamilton's principle, Hamiltonian dynamics, and Hamilton-Jacobi theory.

The book covers a great deal of material in a relatively short and concise manner, yielding a book just over 400 pages long (which is shorter than many books that consider only a few of the individual subjects covered). The book is fairly well organized, and the author does a good job of introducing some difficult concepts in a very concise manner. The associated figures are very simple line diagrams, but are clear and well thought out. The author does not directly state the audience for which book is intended, but in this reviewer's opinion the book should be of interest to any individual seeking basic introductory or overview level information on these subjects. As such the book provides relatively few problems, with the presentation of most theory and derivations in this text being quite condensed; formal worked-out examples are not to be found. Thus, this book would most likely not serve well as a self-standing course textbook, but may make a good supplemental reference or basic reference for those who seek a concise overview of many important classical mechanics (and not so classical, eg, chaos) topics.

What is somewhat different about *Modern Approach to Classical Mechanics* is the author's continued and pervasive discussion of the fact that many (even simple) dynamic systems are chaotic and that as such, even the deterministic equations of motion presented cannot be expected to yield accurate predictions of the arbitrarily distant future. This is the ''modern approach'' indicated in the book's title. In this reviewer's opinion, some of these discussions seem a little forced and the value they bring to the text is questionable. Twenty years ago this material and approach might have been considered revolutionary and of great interest, but it is difficult to be excited about it now given that these concepts that the author stresses already are widely (although not commonly) known. Being that as it may, the author's implicit point that practitioners should not place too much trust in deterministic equations is one that should be made more often to students and engineers (and generally does not appear in foundation level mechanics texts).

III. AUTOMATIC CONTROL

11R8. Underwater Robots: Motion and Force Control of Vehicle-Manipulator Systems. Springer Tracts in Advanced Robotics, Vol 2. - G Antonelli *(Dipartimento di Automazione, Elettromagnetismo, Ingegneria dell'Informazione e Matematica Industriale, Univ degli Studi di Cassino, Via di Biasio 43, Cassino, 03043, Italy).* Springer-Verlag, Berlin. 2003. 183 pp. ISBN 3-540-00054-2. $89.95.

Reviewed by M Pascal (LSC, Univ d'Evry Val d'Essonne, 40 rue du Pelvoux, 91020 Evry, France).

The book originates from a PhD thesis defended by the author in 1999 at Naples University and is concerned by a new advance in robotics related to underwater vehicle-manipulator systems (UVMS). Several interesting applications of these systems can be found in industry and several models of autonomous underwater vehicles (AUV) are developed in various research centers. The design of control laws for underwater robots is a challenging task, owing to the complexity of the system and to the uncertainty in the model parameters, mainly due to the poor knowledge of the hydrodynamic effects. The implementation of standard control algorithms used for ground fixed manipulators is not easy and a necessary improvement of these control laws must be achieved to overcome all the drastic constraints of such systems.

The book involves four chapters followed by two appendices and a wide list of references. A great number of figures of good quality are also included. Chapter 1 is devoted to mechanical modeling of underwater robots composed of a rigid body connected to a serial manipulator. Rigid body's kinematics is recalled, with a special attention to attitude representation by quaternions. Standard models of hydrodynamic effects are briefly presented, and the kinematics of manipulators with mobile base is described by Denavit-Hartenberg method. The dynamical model of the system is expressed in matrix form and its linear dependence with respect to a set of dynamical parameters is underlined. At last, a simplified model of the reaction force applied to the effectors in the occurrence of contacts with the environment is presented.

Chapter 2 deals with inverse kinematic resolution and kinematic control. An underwater vehicle-manipulator system is always redundant due to its mobile base. This redundancy is used in order to achieve both end effectors tracking trajectory and some other control objectives like avoiding singular configurations of the manipulator or energy savings. Several strategies of kinematic control are presented with special attention to the task priority approach and to an interesting application of fuzzy technique. These methods are applied on two models of UVMS and the corresponding numerical simulations seem to give promising results.

In Chapter 3, the dynamic control of UVMS is investigated. The sliding mode control is first proposed and validated by numerical simulation on a special model with eight degrees of freedom. Several other methods are also presented and simulated, including adaptative control, output feedback control, and virtual decomposition based control. At the end of the chapter, experimental results are shown: these results originate from a set of experiments performed at the University of Hawaii on a special model of AUV developed in this institute. Tracking trajectory is investigated by using several kinds of adaptative controls. The performances of these control laws are compared in the presence of disturbances such as current effects, thrusters' fault, and strong noise of the sensors measures. A new adaptative control is also proposed, based on dynamical compensation expressed in a reference frame with respect to which the disturbance is constant, and experiments performed with this method give rather good results.

The last chapter introduces interaction control. A force control scheme without exact dynamical compensation is defined; the redundancy of the system is used to define a task priority inverse kinematics algorithm and suitable secondary tasks. Interesting numerical simulations are performed on a nine degree of freedom UVMS, showing the method's efficiency.

In conclusion, *Underwater Robots: Motion and Force Control of Vehicle Manipulator Systems* provides an interesting reference text about control of underwater robots. The monograph can be useful for researchers interested by this field or, more widely, for scientists involved in control of manipulators with mobile bases or mobile robots in three-dimensional space.

V. MECHANICS OF FLUIDS

11R9. Design Sensitivity Analysis: Computational Issues of Sensitivity Equation Methods. - LG Stanley *(Montana State Univ, Bozeman MT)* and DL Stewart *(Air Force Inst of Tech, Wright Patterson Air Force Base, WPAFB OH).* SIAM, Philadelphia. 2002. 139 pp. ISBN 0-89871-524-5. $65.00.

Reviewed by Yu-Tai Lee (David Taylor Model Basin, 9500 MacArthur Blvd, W Bethesda MD 20817).

Design Sensitivity Analysis is a condensed book that introduces the mathematical aspects of the continuous sensitivity equation methods (CSEMs) for partial differential equations (PDEs). It may serve as a reference book for graduate students or scientists working in the areas of numerical analysis and computational mathematics. A familiarity with real or functional analysis would make reading easier for some chapters of the book.

Sensitivity analysis is an important element in the context of systems optimization and optimal designs. It provides the necessary and critical assessment of the influence of the system/design parameters on the state of the systems or the design evaluations. The book covers only topics related to the construction and analysis of algorithms for computing sensitivities and is not application specific. The authors start with an overview of the early-developed algorithms including the *discretize-then-differentiate* approach, which approximates sensitivities by first employing some discretization scheme to approximate the solution to a PDE and then implicitly differentiating this result to obtain a sensitivity approximation scheme. By pointing out the shortcoming of these early techniques, they lead the readers into the concept of CSEM (ie, a *differentiate-then-discretize scheme*) with a mathematical interpretation of the sensitivity analysis. Examples of simplified linear and nonlinear one-dimensional problems are used to demonstrate the procedures and formulation of the CSEM. Coordinate transformation is discussed for the purpose of practical computational requirements. Both the hybrid SEM (H-SEM) and an abstract version of the semianalytic method (A-SAM) are introduced from the coordinate transformation. Discussion of both CSEMs is included and numerical results for the linear and nonlinear one-dimensional problems are obtained in illustrating the methodologies. The authors devote themselves in the last part of the book to the mathematical framework for the Navier-Stokes equations. They use a finite-element approach to demonstrate methodologies that continuously solve the sensitivity equation with a remeshing strategy and provide improved solutions to the Navier-Stokes equations.

The book is presented in a well-thought-out order and the simplified examples used are properly selected to convey the concepts. Since the topic of the sensitivity analysis serves as the basis to many engineering shape optimization applications, a chapter or two demonstrating the connection of the two subjects seems to be a strategy to increase readership. The finite-element approach is used as the basic discretization scheme for all the examples used in the book. Finite-difference or finite-volume methods, however, are used more frequently in most of the CFD software. The development of the sensitivity analysis calculation for the later schemes is not demonstrated. Instead of using a nomenclature section for the mathematical symbols used, the authors have chosen to refer them to a reference, ie, Wloka 54, quoted in the bibliography section. This may increase readers' difficulty in following the context.

Design Sensitivity Analysis serves as a good reference book for students and researchers to understand the concept of the CSEMs. In order to adapt the methodology for other problems, it would require further detailed formulation. Continuous growth in adapting the CSEM in complex CFD software is, however, envisioned in the near future.

11R10. Foundations and Applications of Mechanics, Volume II: Fluid Mechanics. - CS Jog *(Dept of Mech Eng, Indian Inst of Sci, Bangalore, 560 012, India)*. Narosa Publ, New Delhi, India. Distributed in USA by CRC Press LLC, Boca Raton FL. 2002. 435 pp. ISBN 0-8493-2413-0. $89.95.

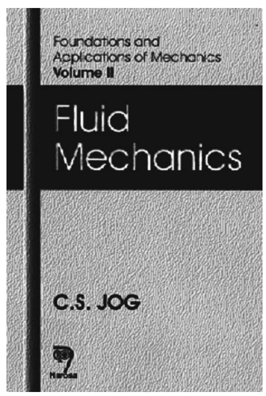
Reviewed by EE Covert (Dept of Aeronaut and Astronaut, MIT, 77 Massachusetts Ave, Rm 9-466, Cambridge MA 02139-4307).

This book is reasonably well described by its title, although the applications of fluid mechanics occur in such a large number of technical activities that any selection of applications is necessarily limited. Volume I is entitled *Continuum Mechanics*, and some of the material in Volume II relies on the earlier work. The chapter titles in this volume are 1, Kinematics and Governing Equations (101 pp); 2, Hydrostatics (17 pp); 3, Ideal Fluid Flow (62 pp); 4, Surface Waves (35 pp); 5, Exact Solutions to Flow Problems of an Incompressible Viscous Fluids (41 pp); 6, Laminar Boundary Layer Theory (49 pp); 7, Low Reynolds Number Hydrodynamics (19 pp); and 8, Compressible Flow (61 pp). Each chapter contains a number of sample problems as well as exercises for the student. Both types of problems seem to be well formulated and of a reasonable level of difficulty.

In his Preface the author writes, "Although we feel that this book treats many topics in a new way, the topic where the treatment is significantly different is that of compressible flow. We have tried to present closed-form solutions whenever possible, some of which we believe to be new. We also emphasize obtaining the solution directly by numerical techniques . . . ."

The subject matter in Chapter 1 follows the structure developed by Truesdale, Noll, and others at the Institute for Rational Mechanics. After worked-out examples of more elementary topics, the chapter concludes with development and use of the integral momentum theorem. The material in Chapters 3 through 7 is presented in a more or less conventional manner.

The concepts behind compressible flow are introduced by means of a one-dimensional control volume, including terms representing the rate of bulk heat addition. The author's solution to these problems leads to a simple classification scheme showing the regions where a solution exists, and the character of the solutions as well. The author has also simplified the manner of presenting the relation between the flow deflection, the shock wave angle, and the Mach number for two-dimensional supersonic flow.



The use of linearization in the treatment of surface waves as contained in Chapter 4 is introduced without adequate preparation in the reviewer's view. Nonetheless, this introduction simplifies the discussion of acoustic waves in the following chapter. Further, the author fails to provide any computer codes, relying on existing commercial computer codes and failing to point out the difficulties the student may face if the details of the code are handled improperly due to inexperience. With his focus on rigor, the reviewer feels the author obscures the physical phenomena.

Further, because of the author's choice of topics, several important subjects in modern fluid mechanics are not mentioned or mentioned very briefly. The omitted topics may lead the student to feel that fluid mechanics is a closed topic. However, unsteady flow and turbulence, serious computational fluid dynamics (CFD), and flow with separation and/or heat transfer problems are not mentioned, or briefly mentioned in passing. The reviewer feels these truly difficult fluid mechanics research issues would warrant a mention, at least in the Preface. The reviewer has concluded that *Foundations and Applications of Mechanics: Volume II Fluid Mechanics* has been prepared for third- or fourth-year students in mathematics or perhaps in classical physics, who deserve a somewhat broader outlook on fluid mechanics.

This book may be best suited for a serious practitioner who is interested in a more rigorous view of the underlying assumptions upon which fluid mechanics rests. The first half of Chapter 1 is ideal for this purpose.

11R11. Perspectives in Flow Control and Optimization. - MD Gunzburger *(Iowa State Univ, Ames IA)*. SIAM, Philadelphia. 2003. 261 pp. ISBN 0-89871-527-X. $70.00.

Reviewed by HG Wood, III (Dept of Mech and Aerospace Eng, Univ of Virginia, Thornton Hall, McCormick Rd, Charlottesville VA 22903-2442).

For anyone interested in flow control or optimization, this book is a must read. Max Gunzburger has done a truly commendable job of providing his perspectives on the subject, and his perspectives are very well informed. He states in the preface that his first goal is "to present an introduction to the development and analysis of several methods," and this is done very well. He also raises issues that arise in the field, and the book has an outstanding bibliography that can lead the reader to other sources. He also points out that this book is not a complete treatment of the subject, as that would take several times the size of this book. However, the book is large enough to provide a really good introduction to the subject but small enough not to be intimidating.

The book consists of seven chapters with the first being a brief history and introduction to the subject. Chapter 2 discusses the different approaches to optimal control and optimization that include the one-shot method and the sensitivity and adjoint based methods. The discussion is clear and provides information in a way that the reader could develop an algorithm from the presentation. Chapter 3 provides illustrations of the approaches discussed in Chapter 2.

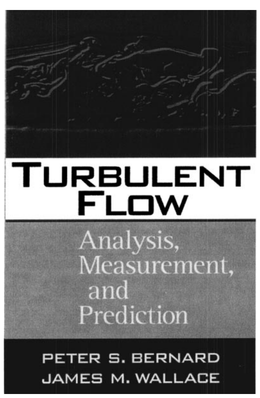
Chapter 4 deals with accuracy and consistency, and Chapter 5 discusses how to reduce the costs of optimization. Chapter 6 presents analysis and numerical analysis of optimal flow control problems. One of the examples is the analysis of a shape control problem for the stationary Navier-Stokes equations. The examples are very well presented and allow the reader to get a very good foundation that provides the necessary information to attack new more complicated problems. Chapter 7 is a brief discussion of feedback control for fluid flows.

In conclusion, this is a very well written book that should be part of the library of anyone interested in fluid dynamics or optimization. This book could also be used as a textbook for a graduate course on the subject.

11R12. Turbulent Flow: Analysis, Measurement, and Prediction. - PS Bernard and JM Wallace *(Univ of Maryland, College Park MD)*. Wiley, Hoboken, NJ. 2002. 497 pp. ISBN 0-471-33219-4. $100.00.

Reviewed by S Yavuzkurt (Dept of Mech Eng, Penn State Univ, 201B Reber Bldg, University Park PA 16802).

This is an excellent book in the area of turbulence analysis, measurement, and predictions, as its title implies. It supplies many aspects of the topic from theory to experiments and helps the reader to see the subject as a whole. It contains cutting edge material in the most fascinating field of turbulence as well as up to date presentations of major theoretical and experimental advances. State-of-the-art turbulence closure and simulations techniques are also included. This book will help greatly in understanding more advanced books and classical and current research articles in this field.



The book contains 12 chapters and it is about 500 pages long. An extensive reference list is given. Figures are drawn very clearly and they are very useful in interpretation of the results of the analysis carried out in the book. Detailed derivations of the equations are given with examples.

Chapters 1 and 2 contain preliminary and also principal concepts in understanding turbulent incompressible flows and an overview of turbulent flow physics and equations including notation, averaging, correlations, Reynolds-averaged momentum, turbulent kinetic energy (TKE), dissipation and Reynolds stress transport equations, spectral analysis, scales of turbulence, vorticity, and turbulent and molecular transport equations for scalars. It is a nice and compact review of these concepts.

Chapter 3 is on experimental and numerical methods in general. It goes into the main techniques used in experiments and how turbulent flows could be simulated on a computer. Experimental topics include hot wire and hot film anemometry—from theory to type of probes used, laser-Doppler velocimetry, laser sheets, particle image velocimetry, and concentration measurement methods. Numerical methods are explained and applications to calculation of flow in a cubical domain and channel flow are given.

Chapter 4 discusses properties of bounded turbulent flows. Topics covered include fully developed channel and pipe flows and boundary layers. Discussion includes basics, Reynolds stresses, TKE and its dissipation, scaling factors, power laws, low speed streaks, bursts, space correlations, experimental visualization, and dynamics of vortex stretching. It is an excellent coverage on these topics.

Chapter 5 deals with properties of free shear flows such as jets, wakes, and mixing layers. Similarity solutions, velocity and vorticity fluctuations, TKE budget, and structure of these flows are covered in detail.

Chapter 6 explains turbulent transport and physics of transport as it is related to Reynolds stresses vorticity flux correlations. Details on Reynolds stress production and vorticity dynamics are very interesting and useful.

Chapter 7 concentrates on theory of idealized turbulent flows such as isotropic and homogeneous turbulence. Homogeneous flows include cases of no production and a flow with uniform TKE production. Concepts of isotropy, energy decay, turbulent Reynolds number, self-similarity, isotropic decay, high Reynolds number equilibrium, self-preservation, von Kármán-Howarth equation, implications on turbulence modeling, and Fourier analysis of the velocity fields are explained in a clear fashion.

Chapter 8 contains all practical important field of turbulence modeling. Types of Reynolds-averaged Navier-Stokes (RANS) models include eddy viscosity, one and two equation and Reynolds stress transport, algebraic stress, and vorticity transport models. Modeling constraints, generalized constitutive models, pressure-strain correlations, second order moment closure, wall functions, near-wall k-ε and Reynolds stress models are discussed.

Chapter 9 covers the applications of turbulence models to channel flows, zero pressure gradient boundary layers, flow separation including backward facing step, hill flow, diffuser flows, and stagnation point flows. Effects of rotation and curvature are also covered.

Chapter 10 deals with the more recent large eddy simulations (LES). Filters, filtered equations and their solutions, numerical considerations, subgrid scale models such as Smagorinsky model, and alternative subgrid scale models and dynamic models are all covered. Applications of LES, vortex methods, vortex elements, dynamic equations and sample results from vortex methods and LES are included.

Chapter 11 deals with analysis of turbulent scalar fields. These topics include plumes, turbulent puff, point source plumes, scalar transport and its models, closure schemes, and random flight models.

Chapter 12 concludes the book with turbulence theory, which covers topics from the early days to the current theories. Gaussian random fields, overview of the theories, direct interaction approximations, renormalization group theories, and thermodynamics of vortex systems make very thought-provoking reading.

Overall, *Turbulent Flow: Analysis, Measurement, and Prediction*, is an invaluable educational and research tool in the area of turbulence. It is an essential book for researchers, instructors, and students who work in the area of turbulent heat, mass, and momentum transport which includes mechanical and aerospace engineers, physicists, and mathematicians, and scientists in the fields of chemistry, biological sciences, and ocean engineering. It will be a valuable addition to the libraries of universities and research institutions. It is strongly recommended by this reviewer.

VI. HEAT TRANSFER

11R13. Boundary Element Method for Heat Conduction: With Applications in Non-Homogeneous Media. Topics in Engineering, Volume 44. - EA Divo and AJ Kassab *(Univ of Central Florida, Orlando FL)*. WIT Press, Southampton, UK. Distributed in USA by Comput Mech, Billerica MA. 2003. 245 pp. CD-Rom included. ISBN 1-85312-771-X. $138.00.

Reviewed by DP Sekulic (Col of Eng, Univ of Kentucky, 210B CRMS Bldg, Lexington KY 40506-0108).

This interesting work is published by WIT Press as the 44th volume in the series *Topics in Engineering* edited by CA Brebbia of the Wessex Institute of Technology, and JJ Connor of the Massachusetts Institute of Technology. The aim of the series is to provide a rapid and informal dissemination of significant new work in engineering. This book represents a monograph in the series devoted to an important numerical tool known under the name *boundary element method* (BEM). The authors are known contributors to that field, and this monograph represents a segment of their work devoted to development of the boundary element methods for heat conduction problems in nonhomogeneous media.

The monograph provides a detailed account of the developed method including: (1) steady-state (isotropic, anisotropic and axisymmetric), and (2) transient formulations. In addition, the method is illustrated by applications to nonlinear heat conduction and inverse problems (parameter estimation in heat conduction).

The book is organized in nine chapters as follows. The opening chapter provides a very brief introduction accompanied by a list of references related to BEM and the corresponding theoretical background important for heat conduction applications in both isotropic and anisotropic heterogeneous media. The Introduction concludes with the statement of the book's purpose, namely, "to formulate a general technique for the development of a boundary integral equation for steady-state and transient heat conduction in heterogeneous isotropic and anisotropic media." Chapter 2 offers a brief review of a BEM formulation for spatially uniform thermal conductivity cases. As a counterpoint, the following Chapter 3 offers the steady state anisotropic formulation, while in Chapter 4 an extension to axisymmetric cases is provided. A transient fundamental solution is discussed in Chapter 5 by using two approaches: (1) the authors' dual-reciprocity method, and (2) a combination of the Laplace transforms and dual-reciprocity methods. An application to nonlinear heat conduction is addressed in (a very short) Chapter 6, including some illustrations of the method's application to cases of one- and two-dimensional temperature fields, in both regular and irregular regions. Chapter 7 is devoted to the problem of identification of an unknown thermal conductivity of a nonhomogeneous medium. In a fairly detailed and well-documented introduction, the inverse problems and the application of BEM to such important engineering topics are presented. Subsequently the related optimizations methods, genetic algorithms, and series expansions are discussed. The chapter concludes, as do most of the other chapters, with examples. The last two chapters, Chapter 8 and 9, together with appendices, offer a presentation of two computer codes ready for implementation.

This demanding technical subject is presented in a well-organized manner. The authors did a good job in setting the text with appealing graphics, including all the color-coded graphic files for each figure provided in the attached CD-ROM. The Fortran codes, given explicitly in the set of appendices, a software included in the CD-ROM, and detailed estimations of the calculation errors in the examples are quite convincing in supporting the author's claim that the proposed method works well.

The authors and their publisher are to be congratulated for the decision to include a CD-ROM. Implementation of the provided software goes smoothly if the reader has proper supporting software drivers. A more prominent note in the main body of the text and/or a separate appendix regarding the software installation and its use would be beneficial, but the reader can get around the related problems relatively easily by exploring the software itself. A number of illustrative examples supported by data generated using the included software are a very good educational tool.

The book does not have an index. An additional drawback (that would have been easily eliminated by a small but importanteffort) is a lack of a detailed explanation of the technical vocabulary. Such an addition is not mandatory, it is rather rarely included in professional technical books, but this reviewer believes that such new and still somewhat esoteric topics like the one presented in this book desperately need a good terminology explanation, in addition to a complete and detailed nomenclature. The technical language is well utilized and nothing is wrong with an inherent need to use it. Still, an effort of the authors in many fields to disseminate new ideas would better be served if a conscious effort to provide a complete and well-defined technical vocabulary (including brief illustrations of most important new concepts), and better cross-referencing (including the index) would be a great addition to any such publication. This book does not have either. The nomenclature is not complete, and numerous omissions are apparent.

In conclusion, this reviewer recommends, without reservations, this book to engineers and researchers in a need for numerical modeling of heat conduction in nonhomogeneous media. *Boundary Element Methods for Heat Conduction: With Applications in Non-Homogeneous Media* (and the provided software) should find an easy way to classrooms of advanced heat transfer and numerical modeling classes in engineering schools.