B O O K  R E V I E W S

Reviewed by JL Wegner (Dept of Mech Eng, Univ of Victoria, Eng Office Wing, Room 537, Victoria BC, V8W 3P6, Canada).

The author attempts to portray the ideas and general principles of the theory of materials within the framework of phenomenological continuum mechanics. It is a well-written rigorous mathematical treatment of classical continuum mechanics and deals with such concepts such as elasticity, plasticity, viscoelasticity, and viscoplasticity in nonlinear materials. The volume consists of 13 chapters. Chapter 1 covers kinematics, that is, the geometry of motion and the deformation of material bodies. The outline follows the script of most texts on classical continuum mechanics—the concepts of material bodies and the material derivative are introduced in Euclidean space. The deformation gradient tensor is introduced, and its physical meaning is described by the transformation of material line, surface, and volume elements. Similar to most treatments on classical continuum mechanics, the appropriate strain and stretch tensors are described. However, the introduction of convective coordinates in this volume is a departure from most treatises on classical continuum mechanics. In this volume, a treatment of strain rates in convective coordinates is provided with the argument that the choice of convective coordinates not only affords a deeper understanding of the strain tensors but also of their strain rates. Chapter 1 finishes with a section on incompatible configurations, that is when a material body can identify a configuration with a non-Euclidean space. Chapter 2 develops the classical balance relations of mechanics, for example: balance of mass in spatial and referential form, conservation of linear and rotational momentum in spatial and referential form. Here, the Cauchy, first Piola-Kirchhoff, weighted Cauchy, and the second Piola-Kirchhoff stress tensors are introduced, as well as their physical significance. This treatise finishes with the balance of mechanical energy and the balance of virtual work.

A comprehensive theory of phenomenological material behavior, based on the general principles of thermomechanics, is developed and presented in this volume. This general theory is expounded in the remaining chapters, beginning in Chapter 3 where the classical balance relations of thermodynamics are presented. In Chapter 4, the terms frame of reference, change of frame, and objectivity are clarified, in preparation for the discussion of the constitutive equations in chapter five.

Classical constitutive relations are presented in Chapter 5, that is, equations defining the perfect fluid, the linear-viscous fluid and the linear-elastic isotropic solid. Two extensions to the model of linear elasticity are also included in this treatise, namely the theories of linear viscoelasticity and plasticity. Chapter 6 contains the results of experimental testing of different materials such as steel and elastomers. The experimental results provide invaluable insight to the reader when compared to the classical theories of continuum mechanics. The classical constitutive models do reflect significant aspects of the material behavior observed. However, there are considerable discrepancies which cannot be resolved within the context of classical theories presented thus far in the volume. Hence, the motivation for a comprehensive theory of phenomenological material behavior based on the general principles of thermomechanics. The aim of material theory is to provide general principles and systematic methods for constructing mathematical models suitably representing the individual properties of material bodies. The general theory of material behavior, as it is developed in Chapter 7, is mainly due to W Noll.

In Chapter 9, the constitutive relations for isotropic elastic and isotropic hyperelastic (compressible, and incompressible) solids are derived. Of interest, the one-dimensional stress-strain curves for the Mooney-Rivlin and Neo-Hookean models are plotted, along with a discussion of their limitations for applications to large deformations. What separates this volume from most on continuum mechanics is the treatise in Chapter 9 on constitutive relations for anisotropic hyperelastic solids.

Chapter 10 considers nonlinear viscoelasticity, and Chapter 11 covers plasticity theory. Chapter 12 covers viscoplasticity, which depicts rate-dependent material behavior with equilibrium hysteresis phenomena. Constitutive models, for all of these types of materials, in thermomechanics is discussed in Chapter 13.

The author achieves his goals of presenting, in a rigorous manner, the ideas and general principles of the theory of materials within the framework of phenomenological continuum mechanics, providing the reader general theories of material behavior from which a reader can select the constitutive model that applies best. Continuum Mechanics and Theory of Materials will be invaluable to advanced graduate students of materials science in engineering and in physics.

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

The mechanics of bodies with defects is typically described by material forces which are negative gradients of an energy or by related path independent integrals. The goal of this book is to draw a parallel between classical linear elastic mechanics and the mechanics of bodies with defects, called here Mechanics in Material Space, which describes a mathematical model for the behavior of material defects such as inclusions, voids, cracks, or dislocations. For example, the Cauchy stress and the Eshelby tensor are viewed as corresponding concepts, as are Newtonian force and deriva-

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Dissipative systems, those without Lagrangians, are discussed by example, including diffusion nonlinear wave equation, linear viscoelasticity based on the archaic spring and dashpot models. The creep C* integral is obtained from a potential for constant strain rate. The primary tool for the construction of conservation laws is the neutral action method.

Conservation laws for coupled systems, such as piezoelectric materials, linear thermoelasticity, and porous materials by analogy with thermoelasticity, are constructed from actions which superpose the sub-systems. The neutral action method is used in the case of time-dependent thermoelasticity.

Finally the techniques are applied to the strength of materials description of bars, shafts, beams, and plates and shells with defects. In these cases, the construction begins with a Lagrangian appropriate to strength of materials, rather than elasticity. Shells are more difficult due to the curvature and are not fully developed.

This book, in a clear presentation, succeeds in establishing a foundation for the mechanics of linear elastic bodies with defects, or mechanics in material space, and in clarifying the parallels with classical linear elastic mechanics. A concise table listing the parallels is given in the Introduction. This fundamental approach in terms of conservation laws is an improvement over dealing with fracture and defects in the classical almost ad hoc manner of defining the path-independent integrals and forces on the defects. Mechanics in Material Space: With Applications to Defect and Fracture Mechanics should be useful to those engaged in research on bodies with defects. It could also be a text for a graduate course on this topic or at least used as a supplement. Although no problems are given, many examples are provided of constructing the conservation laws. Engineering research libraries should own this book.


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

The study of difference schemes is one of the central subjects in Numerical Analysis. Because of the variety and importance of their applications, in particular to Applied Mathematics, difference schemes caused developments in various areas of mathematics.

This monograph is intended as an introduction to difference schemes at the advanced undergraduate and beginning graduate level. The author aimed at breaching the gap that too often exists between engineer-

This is a very well written introductory textbook on the foundations of the direct Boundary Element Method (BEM). It is very useful to both teachers and their under-graduate students in applied mathematics and engineering, as well as those interested in learning the basics of the method.

The emphasis is on the principles and the mathematical derivations of the BEM and not on its numerical implementation. In that sense, the book is unique since most of the existing books emphasize the numerical implementation of the method. Detailed mathematical derivations are provided and solved problems are presented in detail in each chapter to help the student understand the subject matter of the book. Applications are described for one-, two- and three-dimensional problems of potential theory and elastostatics in a unified manner. Only constant elements are considered here for which the computation of singular integrals can be done analytically (in closed form).

There are two aspects of the book the reviewer considers very important and worth mentioning: i) The concepts of the Green’s function and the fundamental solution are both discussed in detail. It is further shown how one can obtain the latter as a combination of Green’s functions defined for different boundary conditions. In many other books these two concepts are used one for the other and this creates confusion. ii) The boundary integral equation for internal points is derived through the method of weighted residuals, which is a very powerful and general method for formulating boundary element and finite element methods.

The whole book consists of seven chapters, one appendix, a bibliography, and a subject index. More specifically, Chapter 1 deals with a discussion on the derivation of the basic field equations (governing equations) of the scalar or vector type and of the second or fourth order in one or more dimensions. Chapter 2 discusses Green’s functions, their properties, derivation, and use in solving boundary value problems.

The concept of the fundamental solution, its relation to Green’s functions, and its derivation are taken up in Chapter 3. The method of weighted residuals is described in Chapter 4, and its use in the derivation of the direct boundary integral equation for one-dimensional, potential, and elastostatic problems are described in Chapters 5, 6, and 7, respectively. In those last three chapters, related problems are solved to illustrate the method and demonstrate its advantages. Finally, the last chapter contains various appendices dealing with details of various mathematical derivations, which were presented in Chapters 3 and 5–7. The book concludes with a list of 20 reference books on the BEM and a short subject index.

The author has certainly succeeded in fulfilling his stated aim of providing an introductory textbook emphasizing the underlying principles of the BEM. Underlying Principles of the Boundary Element Method should be purchased by teachers, under-graduate and graduate students, researchers who would like to start working in the field, and certainly by libraries.


This volume contains 24 papers presented at a symposium honoring Prof Nobuyuki Satofuka on the occasion of his 60th birthday. The contributing authors are from Japan as well as from the international community in Asia, Europe, and North America. The topics covered in this volume are Cartesian scheme, gridless scheme, high order and new schemes, optimization techniques, parallel computation, incompressible and compressible flows, multi-phase flows and solid/fluid interactions, magneto-hydrodynamics, and flow visualization techniques.

This SIAM edition is an unabridged republication of the work first published by New York, Inc., San Francisco (1981). The intention of the first edition was to develop the many important properties and uses of the discrete Fourier transforms of the observed time series. The Addendum indicates the extension of the results to continuous series, spatial series, point processes, and random Schwartz distributions. Extensions to higher-order spectra and nonlinear systems are also suggested.


II. DYNAMICS & VIBRATION


Reviewed by L Gaul (Inst A of Mech, Univ of Stuttgart, Pfaffenwaldring 9, Stuttgart, 70550, Germany) and S Hurlebaus (Inst A of Mech, Univ of Stuttgart, Almandring 5 b, Stuttgart, 70550, Germany).

This work provides, in six chapters, a basic coverage of the science and technology of linear elastic waves. Each chapter contains its own summary, some problem statements, and a list of references.

Chapter 1, Simple Wave Solutions summarizes the basic equations of linear elasticity without any derivation. Then, the Laplace and Fourier transforms and their inverses are introduced. For distinguishing between propagation of a wave and vibration of a bounded medium the author introduced the Poisson summation equation. It is unusual to explain the dispersion feature by wave propagation in a one-dimensional discrete lattice. This would be more appropriate in a book on solid state physics.

Chapter 2, Kinematical Descriptions of Waves describes the kinematics of time-dependent and time-harmonic plane waves. The latter is also used for explaining the asymptotic ray expansion. The author constructs spherical and cylindrical waves from collections of homogeneous and inhomogeneous plane waves, as opposed to the direct derivation from the solution of the equations of motions in the corresponding coordinate system. From a didactic point of view, the readership, in this case the students, would surely prefer the other, the more obvious way. However, for people working in the area it is nice to obtain an additional working.

Chapter 3, entitled Reflection, Refraction and Interfacial Waves, deals with waves at an interface between two materials having different densities and wave velocities. Furthermore, the chapter describes waves that propagate along an interface, while decaying perpendicularly away from it. In this chapter, it becomes obvious that the author does not cover the subject in a complete manner. By considering the reflection, he deals only with an incident longitudinal plane wave, and the refraction is treated only for an incident shear SV plane wave. For a textbook as well as for a reference book, it would be advantageous to deal with the missing cases as well. Obviously, this chapter does not incorporate all possible cases, since the reader is expected to solve the refraction coefficients himself (the solution is given, but the derivation is left to the reader). Furthermore, it would be helpful for a better understanding by the students (the readership in the author’s opinion) to show plots of some reflection and refraction coefficients as a function of the angle of incidence. However, the explanation of the phase matching condition is excellent. As a consequence of dealing with reflections, the Rayleigh wave is introduced in this chapter as well. Again some plots presenting the decaying vertical and horizontal amplitudes with depth of the Rayleigh wave, as well as the orientation of the Rayleigh wave particle orbit would be helpful.

Chapter 4, Green’s Tensor and Integral Representation, discusses the formulation of the integral representations of solutions for rather general problems in elastic wave propagation. In this chapter, the reciprocity identity, the Green’s tensor for a full space, the principle of limiting absorption, the integral representation for a source and a scattering problem, and uniqueness of an unbounded region are introduced. The chapter closes with an example that uses the introduced ideas to derive an integral representation for the scattering of an acoustic wave by an elastic inclusion.

According to its title, Radiation and Diffraction, Chapter 5 deals with the basic propagation processes that are encountered when studying radiation or edge diffraction. The first problem under consideration consists of calculating the transient, antiplane radiation excited by a line source at the surface of a half-space using the Cagniard-DeHoop method to invert the integral transformations. The second one consists of calculating the time-harmonic, inplane radiation from a two-dimensional center of compression buried in a half-space by using plane wave spectral techniques and the method of steepest descent. Finally, the last one treats the calculation of the diffraction of a time harmonic plane antiplane shear wave by a semi-infinite crack using the Wiener-Hopf method and by using matched asymptotic expansions. An appendix describing the relation between the diffraction integral and the Fresnel integral closes the chapter.

The last chapter, Guided Waves and Dispersion, treats antiplane shear problems. The guided waves are constructed by using partial waves, and their dispersions are calculated by using the transverse resonance principle. Both harmonic and transient excitations of a closed waveguide are examined by using a mode expansion. The harmonic excitation of an open waveguide by a source is also studied by using both ray and mode representations. The last problem under consideration deals with the propagation in a closed waveguide with a slowly varying thickness using an asymptotic expansion that combines features of both rays and modes. The chapter ends by examining the propagation of information and energy with the group velocity.

All derivations are carefully developed, however, more illustrations would enhance the mathematical development and understanding. Plenty of textual explanation is provided to clarify the topic under consideration. The book has a detailed table of contents and a rich subject index. However, the reference list could be extended by adding some other basic wave propagation books such as Graff [1], Rose [2], Bedford and Drumheller [3], Doyle [4], Kolsky [5] etc. Due to the incomplete treatment of some problem areas and neglecting some basic topics, the book provides an initiative for the reader to extend the ideas and to solve problems which are not included.

In summary, Linear Elastic Waves is a useful work whose major contribution lies in its description and mathematical derivations. Readers may find, however, that the book owes a substantial debt to Achenbach’s classic treatment of the subject [6], since Professor Achenbach was the research advisor of the author. However, Achenbach’s book is out of print, and therefore, this book, which is only about half of the size of Achenbach’s book, would be a welcome replacement to graduate students having started in the subject of wave propagation.

References


Reviewed by K Yagasaki (Dept of Mech and Syst Eng, Gifu Univ, 1-1 Yanaasido, Gifu, 501-1193, Japan).

This book provides backgrounds in some techniques for analyzing nonlinear structural dynamical systems and is intended for
The generalization presents a method of system identification for MDOF systems. Finally, three experimental examples of a built-in beam rig, automotive shock absorber, and bilinear beam rig (the last of which is motivated from constructing a system with localized damage in the benchmark of fault detection algorithms) are given, and the techniques of the earlier chapters are applied to demonstrate their effectiveness in Chapter 9. This chapter is especially interesting for the reader from a practical point of view. A substantial set of appendices is also valuable for not only the beginners, but also ordinary researchers in the field.

In summary, this reviewer recommends Nonlinearity in Structural Dynamics: Detection, Identification and Modeling for students and researchers in structural dynamics who want to study techniques for detection of nonlinearity and system identification in realistic problems.


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

This book is intended to be a "comprehensive textbook that guides the reader through the theory and practice of satellite orbit prediction and determination." This reviewer believes the book does just that. However, it is stated that it is intended for advanced undergraduate or graduate courses, and for professionals on the job. The undergraduate would likely have to struggle with the material presented in the book for two reasons. One is that s/he would not have a sufficient background in all the areas covered, and the other is that a significant amount of material is presented in such a concise form that it does not allow one to pick up the background material from the text. The diligent student, however, could refer to the ample references provided (approximately 320) to fill in the background gaps. The author's focus is on providing material currently being used for orbit prediction and determination. (A good portion of the references are from the 1990s.) There is little, if any, discussion of analytic approaches (such as perturbation techniques) that classically have been applied to such problems. There is an extensive amount of practical information regarding force modeling, measurements and filtering, tracking, reckoning time, and computer algorithms. This information is presented in nine chapters, two appendices, and one CD.

The first chapter, entitled Around the World in a Hundred Minutes, summarizes the broad range and types of orbits encountered and has excellent color photos of some recent satellites. The second chapter, Introductory Astrodynamics, is approximately 30 pages and reviews the basic two-body theory with its implications on tracking and determining orbit characteristics. Chapter 3 devotes about 60 pages to the modeling of forces, including the higher harmonics of the gravitational field, the gravitational effects of the Sun and the Moon, Solar radiation, and atmospheric drag. In addition, some consideration is paid to precision modeling with GPS satellites in mind. Chapter 4 devotes about 40 pages to the various methods of integration for precise orbit prediction. The emphasis is on comparing accuracy and effort of the different techniques. Chapter 5 is a very nice discussion of the various time and reference systems which takes about 30 pages. Tracking and observation models are discussed in Chapter 6. These include radar and laser tracking, range, range rate, and the use of GPS signals. Chapter 7 introduces the linearization procedure to supply the required background for Chapter 8 which is Orbit Determination and Parameter Estimation. These chapters occupy about 60 pages. In this next to last chapter, the least squares and Kalman filtering methods are presented. Finally, Chapter 9 supplies three application examples using real data, including one demonstrating error analysis, real time orbit determination, and orbit determination using a relay satellite.

If that were the complete book, this reviewer would suggest that it would be a good addition to your library. However, there is more. The authors have provided a CD with some C++ codes that support all the problems at the ends of the chapters, the three application problems in Chapter 9, and in addition, have some generic satellite codes to support problems that the reader might want to attack. In this generic library are mathematical and astronomical constants, integration routines for differential equations, least squares estimation and Kalman filtering, a force model which includes a 20×20 gravitational model, Sun and Moon gravitational effects, appropriate coordinate transformations, calendar-time calculations, and some vector/matrix opera-
tions. The codes that support the problems at the end of each chapter help to improve the understanding of the chapter and aid readers who are doing a self study. In addition, the CD has an extensive list of website links which support most of the topics in the book and more.

**Satellite Orbits: Models, Methods, and Applications** would be a valuable addition to the library of any engineer or scientist interested in the practical aspects of orbit prediction and determination. There are few books currently available that cover this material under a single cover, the most recent being, *Fundamentals of Astrodynamics and Applications* by DA Vallado, (McGraw Hill, 1997), which would be a good complimentary text to **Satellite Orbits**. The comprehensive reference list along with the CD supplied codes make this book unique in its area.


This compilation of 47 full-length, peer-reviewed papers covers the following major topics: fluid, thermal, and fluid-structure systems, including advances in shock wave and blast, safety assessment, and structural mechanics and integrity assessment; and shock wave and blasts, structural mechanics, integrity, and safety assessment, which can be advances in fluid dynamics, computational fluid dynamics, thermal problems, and full-structure interactions.


Composed of 25 full-length, peer-reviewed papers, this volume presents information contributing to the understanding of vibration excitation mechanisms with specialization in cross flow, heat exchanger to cylinder arrays applied to heat exchanger tube bundles.


This proceedings is composed of 23 full-length, peer-reviewed papers on vibration excitation mechanization in axial flow-induced vibration, piping systems and acoustics, compressors, and cylindrical shells.


This is a special issue of Revue Européenne des Elements Finis which is dedicated to mathemati- cal and numerical fluid-structure inter- action. Fluid-structure interaction concerns the study of mechanical systems involving a fluid and a structure which have mechanical influence on each other. In this special issue, there are two particular focuses: consideration of compressible fluids and concentration on unsteady models. There are nine individually authored chapters: Fluid-Structure Interaction: A Theoretical Point of View (C Grandmont, Y Maday); Design of Efficient Partitioned Procedures for the Transient Solution of Aerodynamic Problems (P Piperno, C Farhat); Deriving Adequate Formulations for Fluid-Structure Interaction Problems: from ALE to Transpiration (T Fanion, M cannon, P Le Tallec); Sensitivity Analysis and Control in an Elastic CAD-Free Framework for Multi-Model Configurations (B Mohammadi); Numerical Study of the Aeroelastic Stability of an Overexpanded Rocket Nozzle (E Lefrancois, G Dhatt, D Vandromme); Fully Coupled Fluid-Structure Al- gorithms for Aerelasticity and Forced Vibration Induced Flutter: Applications to a Compressed Cascade (P Leyland, V Carstens, F Blom, T Tefy); Interaction between a Pulsating Flow and a Perforated Membrane (R Lardat, R Carpentier, B Koobus, F Schall, F Farhat, J-F Guery, P Della Pietra); Analysis of a Possible Coupling in a Thrust Inverter (R Lardat, B Koobus, E Schall, A Dervieux, C Farhat); and Aerelastic Coupling between a Thin Divergent and High Pressure Jets (E Schall, R Lardat, A Dervieux, B Koobus, G Farhat).


This proceedings is divided into the following six sections: Advances in guidance and control (8 papers); Autonomous and remotely piloted ter- restrial landing (8 papers); Landing on planetary bodies (5 papers); Guidance and control story- board displays (7 papers); Optical control (6 papers); and Recent experiences in guidance and control (7 papers).


This book discusses direct hit technology in conjunction with a new class of warheads coined near miss or direct hit warhead technology. This book discusses the challenges of designing small lethality enhancement technologies that can be implemented on a direct hit kill vehicle. The book provides designers with a knowledge base of new warhead technologies that can be used in conjunction with direct hit missiles. The ballistic missile and warhead community is provided with new ideas and logic to assess antiballistic missile systems.


This reference text gives an overview of the current state of nonlinear wave mechanics in both elastic and fluid media. Consisting of self-contained chapters, the book covers new aspects on strong discontinuities (shock waves) and lo- calized self-preserving (permanent) waves (solitary waves and solitons). Special attention is de- voted to the kinematics and dynamics of permanent waves while dissipative effects are added to the original balance between nonlinearity and dispersion.

Key features include survey chapters written in an accessible style by leading specialists; cover- age of emerging topics in the field; interdiscipli- nary approach integrating mathematical theory and physical applications of nonlinear waves in elastic and fluid media; and intrinsic mechanisms of propagation of different types of nonlinear waves; presentation of analytical meth- ods for solving wave propagation problems in elastic and fluid media; and a user-friendly index,


This volume of 31 full-length, peer-reviewed papers is devoted to exploring how materials in- teract under extreme loading conditions. The following topics are covered: sloshing and fluid-structure interaction; thermal hydraulic phenomena in vessels, piping, and components; and explosive loading and damages to projectiles and automobiles.


Reviewed by PJ Eagle (Exp and Comput Mech, DaimlerChrysler Corp, 800 Chrysler Dr, Auburn Hill MI 48326-2757).

This book is a monograph devoted to methods for analyzing linear and nonlinear multivariable control system problems. The stated aim of the text is to be “used to teach undergraduate and graduate classes in automatic control at electrical, mechanical and aerospace engineering departments.” While this text has several problems achieving this aim (as described below), it is a unique re- source that should not be overlooked as an addition to a library of books on control systems. The book is geared toward using the popular MATLAB® and SIMULINK™ software as tools for analysis and data pre- sentation. The book is not at a very funda- mental level and does not contain practice problems. As such, it would not be a good choice as an undergraduate text. However, it is a resource of a large quantity of solved example problems (including a CD-ROM of MATLAB/SIMULINK source code) re- lated to multivariable control and nonlinear systems that is not found in many similar texts. For this reason, this book would be a valuable resource for upper-level graduate students pursuing research topics in control systems.
The book consists of five main sections divided into numerous subsections. There is no list of nomenclature and symbols, but the notation is consistent with those used in standard control system practice. There is a brief index as well as a list of references which is simply a list of publications that are not necessarily related to the content of the book. The reference list is divided into topical sections. For reasons that are not clear, the list of “Papers in Control” is largely populated by the author’s publications. The book was well reviewed for type-setting irregularities and typographic errors. There is an abundance of figures, most of which are graphs and other screen output from MATLAB. The line art does not appear to be professionally executed, but it is clear and consistent.

The book contains an introduction to MATLAB that begins as being overly simple, but covers a wide range of the fundamentals necessary to apply this tool to solving controls problems. The level of detail is useful for readers who are teaching themselves MATLAB for use in these types of applications. The coverage of MATLAB examples is so extensive that some diagrams and output figures are too complex for a book of this type. Nonetheless, the author has taken great care to painstakingly document the examples in text and figure. Some editorial oversight is the coverage of state space theory after MATLAB has already been applied to some state space analysis.

One of the best features of this book is its clear presentation of Hamilton-Jacobi and Lyapunov methods coupled with numerous examples, complete with simulation data and MATLAB files on CD-ROM. Graduate students and researchers in optimal control will benefit from this level of detail. It should be noted that while these examples are detailed enough to run simulations and verify output, they expect the reader to be familiar with a fairly high level of domain-specific knowledge (such as aircraft dynamics). Some examples are flush with irrelevant details like how long the simulation took to run using a particular computer. Other examples suffer from poor practices in significant figures and the lack of appropriate diagrams (a complex dynamic model of a robot is presented with no supporting diagram). In contrast, there is a well-documented and laboriously complete example on induction motor control that would be invaluable to students struggling with the practices in nonlinear control.

Even with the above criticisms, this book would be an excellent starting point for a graduate student pursuing problems in discrete-time systems with optimal control.

In summary, this reviewer would definitely recommend Control Systems Theory with Engineering Applications to students or libraries seeking control system and MATLAB/SIMULINK reference texts. This is a very complete and practical resource. It is not a teaching textbook, but it would be an outstanding supplement to an advanced graduate course in nonlinear control.


Reviewed by J Chow (Ady Tech Center, Org L9-24, Lockheed Martin, 3251 Hanover St, Palo Alto CA 94304-1191).

The author has written a book that seeks to present practical, general nonlinear, and robust control methods for hyperbolic and parabolic PDE systems, and to illustrate their application to transport-reaction processes that are found in the chemical industry. There is also an attempt to compare their effectiveness with respect to traditional control methods for PDE systems. This book is written for process control engineers, researchers, and students at the graduate level.

The field of chemical engineering contains many different examples of hyperbolic and parabolic PDE systems. As the author rightly states in his preface, “The interest in control of nonlinear partial differential equation (PDE) systems has been triggered by the need to achieve tight distributed control of transport-reaction processes that exhibit highly nonlinear behavior and strong spatial variations.” As a result, there is a requirement to provide the chemical process community with an overview of the most recent advances in nonlinear PDE control theory.

In this book, general and practical methods for synthesizing nonlinear controllers for hyperbolic and parabolic PDE systems are systematically developed, and then extended to include robustness. Geometric and Lyapunov-based control techniques are used to synthesize nonlinear and robust controllers that use a finite number of measurement sensors and control actuators to achieve a stable closed-loop system in the face of model uncertainty. All the PDE systems considered in this text are assumed to have unique solutions that are sufficiently smooth. Readers are assumed to have a basic knowledge about PDE systems and control theories.

The first two chapters focus first on quasi-linear, first-order hyperbolic PDE systems, and then on the same type of hyperbolic PDE systems, but those which include time-varying uncertain variables and unmodeled dynamics. These control methods are based on geometric control concepts and are applied to nonisothermal plug-flow reactor examples. The next two chapters focus on developing general methods for quasi-linear parabolic PDE systems using Galerkin’s method and approximate inertial manifolds, both with and without time-varying uncertain variables. Examples of the methodology’s successful application to the control of temperature profiles for catalytic rods and nonisothermal reactors are presented for illustration. The following chapter deals with the nonlinear and robust control of parabolic PDE systems with moving boundaries, i.e., time-dependent spatial domains. General methods for synthesizing nonlinear and robust time-varying output feedback controllers are presented, again using a combination of Galerkin’s method and the approximate inertial manifold. The final chapter presents case studies in which the control methods derived in earlier chapters for parabolic PDE systems are applied. In particular, the control of a rapid thermal chemical vapor deposition process and a Czochralski crystal growth process are illustrated and simulated. The book ends with an extensive set of mathematical proofs to support the results developed in the preceding chapters. It also has an extensive bibliography and is sprinkled throughout with clear figures and examples.

Nonlinear and Robust Control of PDE Systems is a well-written book that succeeds in its objectives and is possibly the first one to do so. The control theories and synthesis methodologies are described in exhaustive mathematical detail. This book can also be recommended to researchers and engineers in other fields who are faced with the task of developing nonlinear feedback and robust controllers for hyperbolic and parabolic PDE systems. They will find this book to be very useful because it provides the reader with the general framework for nonlinear feedback control based on detailed mathematical models.

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This proceedings focuses mainly on problems of mechanical engineering and control. The opening lecture, by B Roth, presents an overview of the theoretical basis for the mechanical aspects of robot design. The general lecture, by M Vukobratovic, discusses the theory and practice of new frontier of robotics.

The regular papers included in this volume illustrate significant contributions in mechanics (13 papers), motion control (7), synthesis and design (8), legged locomotion (11), sensing and machine intelligence (2), applications (5), and biomechanical aspects of robots and manipulators (4).


IV. MECHANICS OF SOLIDS


Reviewed by ME Popescu (Dept of Civil and Archit Eng, Illinois Inst of Tech, 3201 S Dearborn St, Chicago IL 60616).

The US National Committee on Rock Mechanics defined rock mechanics as “the theoretical and applied science of the mechanical behavior of rock and rock masses; it is that branch of mechanics concerned with the response of rock and rock masses to the forces fields of their physical environment.” Rock engineering is concerned with the investigation, design, construction, and performance of engineered structures built on or in rock. It involves engineering applications of the science of rock mechanics.

Rock mechanics and rock engineering are not synonymous although the terms are sometimes used as if they were interchangeable. The Statutes of the International Society for Rock Mechanics say that “The field of rock mechanics is taken to include all studies relative to the physical and mechanical behavior of rocks and rock masses and the applications of this knowledge for the better understanding of geological processes and in the field of engineering.” Thus, rock mechanics is seen as having a major input into rock engineering, but as having application in other areas as well.

Despite the long history of the use of rock as a construction material, the development of the mechanics of rock mechanics and of a mechanics-based rock engineering design methodology occurred only relatively recently. The initial development of these design approaches appears to have been associated largely with civil engineering projects and especially with hydro-electric power schemes. An early manifestation of the emergence of rock engineering was the publication in Vienna in 1929 of the first volume of the journal Geologie und Bauwesen (Geology and Construction) edited by Josef Stini. In 1962, the journal’s name was changed to Felsmechanik and Ingenieurgeologie (Rock Mechanics and Engineering Geology) under the editorship of Leopold Muller. The other major journal in the field, the International Journal of Rock Mechanics and Mining Sciences, which was founded in the United Kingdom in 1964, had an initial mining emphasis.

Annual colloquia on rock mechanics have been held in Austria since 1950 and annual symposia in the United States of America since 1956. Under the leadership of Leopold Muller, the International Society for Rock Mechanics was formed in 1962. The Society’s first International Congress was held in Lisbon, Portugal in 1966.

This book, Engineering Rock Mechanics: An Introduction to the Principles by Hudson and Harrison, and its companion volume Engineering Rock Mechanics: Part 2: Illustrative Worked Examples by JP Harrison and JA Hudson (see next Review, 3R26), are authoritative references on engineering rock mechanics, consolidating into one handy source information once widely scattered throughout the literature. They include new, previously unpublished material; present the fundamental concepts of rock mechanics; and appraise their practical application in industrial projects such as tunneling and mining.

Engineering Rock Mechanics: An Introduction to the Principles is based on the content of the integrated engineering rock mechanics course given at Imperial College by the authors. As stated in the book preface the authors made a special attempt to present the principles of rock mechanics and their place in the engineering context. The layout follows a logical course. Chapters 1–13 cover the basic subjects of rock mechanics such as stress, strain, permeability, discontinuities, anisotropy and inhomogeneity, testing techniques, rock mass classification, rock dynamics and time dependent aspects. Chapter 14, entitled Rock mechanics interactions and rock engineering systems, discusses the principles of rock engineering systems and interaction matrix as the basic device used in rock engineering systems. Soft systems approach is used if the state variables are conceptual in nature while the fully-coupled model or the hard systems approach is used if the state variables are physical variables.

Chapters 15–20 cover major applications in rock engineering including instability and slope stabilization, rock excavations. There are two appendices at the end of the book on stress and strain analysis and hemispherical projection methods, respectively.

Concluding with an exhaustive bibliography of significant references and a very well-organized index, the book addresses the principles of engineering rock mechanics and is not intended to be truly comprehensive in the sense of including all information on the rock engineering subject. Readers requiring more information are referred to the five-volume compendium Comprehensive Rock Engineering, edited by the first author and also published by Pergamon.

Engineering Rock Mechanics: An Introduction to the Principles and its companion volume. Engineering Rock Mechanics: Part 2. Illustrative Worked Examples, deftly and elegantly bring together timely and in-depth information on one of the most active fields of applied mechanics. The books are written by authors with long standing teaching, research, and consulting experience in rock mechanics engineering.

These books are clearly written and the text, figures, and tables are produced to a high quality. These two books represent a significant contribution to the challenging field of rock mechanics and should be recommended as a reference for university libraries serving civil engineering, mining engineering, and geological engineering programs, as well as for research corporations, and engineering consulting firms.


Reviewed by ME Popescu (Dept of Civil and Archit Eng, Illinois Inst of Tech, 3201 S Dearborn St, Chicago IL 60616).

This book reviewed here is a companion book to Engineering Rock Mechanics: An Introduction to the Principles by Hudson and Harrison (see previous Review, 3R25). This companion book contains worked examples of engineering rock mechanics in action as the subject applies to civil, mining, petroleum, and environmental engineering. This book can be used as a stand-alone textbook or as a complement to the introductory book. The book covers the necessary understanding and the key techniques supporting the rock engineering design of structural foundations, dams, rock slopes, tunnels, caverns, hydroelectric schemes, and mines.

The authors adopted a question-and-worked-answer presentation—the question and answer sets have been collated into 20 chapters which match the subject matter of
Engineering Rock Mechanics: An Introduction to the Principles: Chapters 1–13 on rock mechanics principles and Chapters 14–20 on applications in rock engineering. Part A entitled “Illustrative worked examples—Questions and answers” can be read as a narrative consisting of sequences of text, questions, and answers, while in Part B entitled “Questions only” the same questions can be tackled without the answers being visible.

Each chapter of Part A has the same format: Section 1—Introductory aide-memoire to the chapter subject; Section 2—Questions with worked answers that illustrate the principles of the rock mechanics subject and the associated rock engineering design issues; and Section 3—Additional points, often reinforcing the most important aspect of the subject. Part B includes question sets that give examples of the procedures often encountered in practice. It emphasizes that a good designer needs not only knowledge for designing (technical knowledge), but also must have knowledge about designing (an appropriate process to follow).

There are three appendices. Appendix A contains a 3D stress cube cut-out which can be copied and made into a model as an attachment form of the software AntHill. Appendix B contains a semispherical projection sheet which can be also copied and used. Appendix C contains RMR and Q rock mass classification tables. Exhaustive references, lists of units and symbols, and a subject index add very much to the value of the book.

Engineering Rock Mechanics: An Introduction to the Principles and its companion volume, Engineering Rock Mechanics. Part 2: Illustrative Worked Examples, deftly and elegantly bring together timely and in-depth information on one of the most active fields of applied mechanics. The books are written by authors with long standing teaching, research, and consulting experience in rock mechanics engineering.

These books are clearly written and the text, figures, and tables are produced to a high quality. These two books represent a significant contribution to the challenging field of rock mechanics and should be recommended as a reference for university libraries serving civil engineering, mining engineering, and geological engineering programs, as well as for research corporations, and engineering consulting firms.


This is a textbook, which was completed with the support of the European Commission under the Leonardo da Vinci program. It is an unusual book. It is composed by 33 authors, 11 of whom may be characterized as students. This reminds me of a Talmudic dictum stating that one can learn a lot from his teachers, even more from his colleagues, and the most from one’s students. This cooperation between the editors, university professors, and the PhD students is a great welcome one. The authors pose a rightful and timely question: “What is needed to be done in order to improve and to make progress in the use of full probabilistic reliability assessment?”

Indeed, there are many research papers in this area by now (possibly several thousand), with attendant monographs, specialized regional and international conferences with multi-volume proceedings, contributed and keynote lectures. Yet the above-mentioned problem is seldom being addressed. This unfortunate situation makes an impression that the methods treating uncertainty constitute a second-order effect, or a curiosity that is unconnected with reality, for the designers and the deterministically minded engineers want to get some simple tools from the researchers engaged in the probabilistic mechanics.

Returning to the authors’ question, their reply is as follows: “The attention should be focused to the qualitatively new reliability assessment methods considering the rapidly increasing potential of the computer and information technology.” Further that “The formation from the ‘pre-computer’ reliability assessment concepts to the new generation of ‘computer era technology’ which makes workable a fully probabilistic concept, will require education of designers and a ‘re-engineering’ of the whole assessment procedure of structural reliability.”

The authors suggest massive utilization of the Monte Carlo method. The book has an attachment form of the software (CD-ROM) to demonstrate the feasibility of probabilistic reliability assessment.

The textbook comprises 16 chapters and three appendices. Chapter 2 explains the Monte Carlo simulation technique. The authors explain: “Simulation is an experiment performed on a model rather than on a real system.” They note wisely that “There is not a generally accepted exact definition of the concept of randomness.” They discuss basic notions of probability theory and statistics, including random variables, histograms, and the Monte Carlo method, along with uncertainty of results, variance reduction techniques, and typical problems illustrating what can be calculated using Monte Carlo simulation. Then they proceed to the random number and pseudorandom generators, including testing of their quality, and a transformation method. They have developed simulation based reliability assessment (SBRA) programs. The load combination program (LoadCom) is a tool for loads effect combination analysis according to allowable stress design, partial safety factor design, and limit states design according to Canadian National Standards. They also describe response combination (ResCom) damage accumulation (DamAc), and an AntHill program allowing evaluation and display of multi-dimensional random variables. This permits a direct reliability assessment, as well as an iteration procedure for model parameter estimation.

In Chapter 3, the authors present a problem of interpretation of the limit state philosophy, including serviceability limit states, static and dynamic models, and load effects. Chapter 4 is devoted to single component, load combinations; dead load effects for single-story buildings; analysis of principal stress at a point of a beam; combined dead, live, and snow load effects; and dependent load effects. Chapter 5 treats examples associated with resistance of structural elements and components. Ultimate bearing capacity of reinforced concrete cross-section subjected to bending and compression, resistance of short composite columns, variability of the strength of steel-concrete composite beams, post buckling resistance of compressed rectangular plates, tension resistance of a bolted beam to a beam connection, and shear resistance of a better beam are treated.

Structural elements are discussed in the sixth chapter. The material includes pipes under internal pressure, nailed timber-to-timber joint, dowelled steel-to-timber joint, stability of a portion of a continuous girder exposed to several variable loads and to a moving variable load as many others. Chapters 7 and 8 are dedicated, respectively, to the first-order and second-order theories. The ninth chapter discusses reliability of retaining walls and slopes, whereas Chapter 10 deals with prestressed concrete examples. Accumulation of damage is discussed in Chapter 11; serviceability is treated in Chapter 12; and Chapter 13 deals with special situations. The title of Chapter 14 is “From Components to Systems.” It includes assessment of coupled steel beams, determination of the safety of a bolted lap joint, as well as that of the bolted web plate joint. Eurocodes are discussed in Chapter 15. Chapter 16 deals with the Bayesian approach.

Numerous examples included in the text allow for a multifaceted education in a unified reliability context. It is an indispensable reference to those who want to see
probabilistic methods in action. The Monte
Carlo method is shown as a powerful tech-
nique for dealing with a large variety of en-
geniering problems. Engineers may use it in
order to contrast their own methodologies
with the ones presented in the book in view
of bringing some new aspects of the topics
discussed. This reviewer would want to see
the discussion of dependent random vari-
ables, correlations, as well as the sources of
the assumptions of the adopted probabilistic
densities.

Probabilistic Assessment of Structures us-
ing Monte Carlo Simulations is an excellent
text for educating practicing engineers.
Some of the examples could also be
adopted in various courses that have a de-
terministic flavor in order to demonstrate
the philosophy of probabilistic design. This
book, therefore, is a welcome new bird,
telling us that possibly the probabilistic
spring may still arrive for design purposes,
not only for research.

Foundation of Engineering Mechanics. -
NA Alfutov (M J Dept, Moscow State Univ
Tech, 2-nd Baumanskaya Str 5, Moscow,
107005, Russia). Springer-Verlag, Berlin.
$99.00.

Reviewed by J Wauer (Inst fur Tech Mech,
Univ Karlsruhe, Kaiserstr 12, Karlsruhe,
D-76128, Germany).

The stability loss of slender structural sys-
tems under loading is still an actual field of
research in mechanics. Every engineer
nowadays has to know the occurring phe-
nomena and the analytical methods to
explain them. In general, such stability inves-
tigations have to be based on a dynamic
approach. However, in many practical ap-
lications, a static approach can be applied,
and this is the objective of the present book.
It is clearly pointed out by the author that
only the static stability of elastic systems is
considered, and that the complete math-
ematical framework is explained for classi-
cal structural members such as columns,
plates, and (cylindrical) shells. The draw-
back of this restriction is being compen-
sated for by the demand to give a very clear
and straightforward introduction into the
basics of this part of an important field.

The book is arranged in seven chapters
(and an appendix) together with a list of
references and a subject index both cover-
ning the complete content of the book.
Chapter 1 deals with the basic theory of
elastic stability. It stresses the equilibrium
paths for deformed systems, stable or un-
stable equilibrium states and bifurcation
points as well as limit points and critical
loads, including energy criteria for bifur-
cational stability loss and a corresponding
method using homogeneous linearized
equations. It also discusses the supercritical
behavior and the stability of elastic struc-
tures under combined loading. A summariz-
ing statement on stability problems for slen-
der structures concludes the chapter.
Chapter 2 discusses the energy method
more in detail starting with the principle of
virtual displacements and variational ap-
proaches in the linear theory of elasticity.
Two basic forms of the presented energy
criterion for bifurcational stability loss are
introduced and generalized as the Bryan
and the Timoshenko form. The significance
of the Rayleigh-Ritz method in the stability
analysis is addressed, and the Galerkin
method and its relationship to the Rayleigh-
Ritz method is explained.

Chapter 3 covers the stability of straight
columns, essentially under axial forces.
Elastic foundations and elastic supports are
included in the analysis, and the stability of
self-gravitating column is examined. In ad-
dition, the problem of lateral-torsional
beam buckling is dealt with, and the influ-
ence of transverse shear strains is also ad-
dressed.

Chapters 4 and 5 concern the stability of
plates. Chapter 4 discusses the differential
equation approach while Chapter 5 is fo-
cused on the energy method. Both rectan-
gular and circular plates under mid-plane
distributed force-loading are considered.
Transverse shear effects, thermoelastic
buckling, and plates under local loads are
supplementing topics.

Chapter 6 is devoted to the stability of
(cylindrical) shells starting with corre-
sponding considerations on circular rings.
Axial compression and external radial pres-
sure are the preferred load cases, but shells
under torsion and transverse bending also
find attention. Finally, stiffened shells (by
elastic frames) are addressed.

Chapter 7 gives an outlook to nonlinear
problems starting with a discussion of the
supercritical behavior of a compressed bar
after stability loss and extending the exami-
nation to plates and shells including initial
imperfections.

The appendix gives a compact introduc-
tion into eigenvalue problems, stationary
values, and extrema of functions and func-
tionals.

The restriction mentioned at the begin-
ning detracts from the value of the book for
all persons interested in receiving a general
view of the whole field of structural stabil-
ity. On the other hand, to find a clear intro-
duction about the static stability and to un-
derstand the peculiar phenomena in this
area, it might be better to concentrate on the
basics for simple structural members. In
this sense, Stability of Elastic Structures
can be recommended for all undergraduate
and also graduate courses in engineering
science, in particular civil and aeronautic
engineering. Also, for practical engineers in
these fields, it is a good reference. The book
is well written with good quality figures and
illustrations. It is worth being pur-
chased by every engineering library.

3R29. Theory of Porous Media: High-
lights in Historical Development and
Current State. - R de Boer (Inst fur
Mechanik, Univ Essen, Fachbereich 10
Bauwesen, Essen, D-45117, Germany).
ISBN 3-540-65982-X. $95.00.

Reviewed by N Katsube (Dept of Mech
Eng, Ohio State Univ, 206 W 18th Ave, Co-
lumbus OH 43210).

This book consists of historical and recent
development of porous material theory, can
be used as a reference book in this area. In
the early and classical era, general develop-
ment of continuum mechanics such as
Cauchy’s formulation of the stress concept,
the development of linear elasticity theory,
and the foundation of thermodynamics are
summarized. At the end of each chapter,
biographical notes of the important con-
tributors are outlined. There the readers
could learn about the lives of these prominent
researchers, including their characters,
and the nature of scholarly debates. The
readers can also learn about how the lives of
these researchers were influenced by the
historical events, and how failure in one
event had led to success in another.

In the modern era, the emphasis is placed
on the porous materials. The historical re-
view includes the controversy between Fil-
lunger and von Terzaghi and the subsequent
development of the theory by Biot and oth-
ers. Further developments of elasticity and
plasticity theories and a more modern
framework of continuum mechanics and
mixture theory are also discussed.

The current state of porous material
theory reflects the author’s work as well as the
related work developed mostly in Eu-
rop. It is based on the assumption that the
deformation gradient of the constituent can
be separated into the part due to the real
material and the part due to the change of
the pores in size and shape through a mul-
tiplicative decomposition process. In devel-
opmg constitutive theories, the principle of
material objectivity as well as entropy in-
equality is employed. An extensive develop-
ment of a porous material theory is
presented based on these theoretical frame-
works. Theory of Porous Media: Highlights in
Historical Development and Current State
is a great book to have if you would like to
know about the historical development of
porous material theory since many of the letters and articles written by the researchers in early days are not available in English. In addition, if you would like to follow the recent development of porous material theory, which is consistent with the above stated assumptions, this book will provide an extensive review. However, the reader should be aware that this is not the only approach available in the area of porous materials. There are a number of different approaches available for the development of constitutive behavior of porous materials. These other approaches are more phenomenologically based and often motivated by experimental observations. The developed models are verified by experimental data and used to solve important practical problems.

This is a sequel to the author’s earlier text on Space Transportation: A Systems Approach to Analysis and Design, published in 1999. Both texts represent a comprehensive exposition of the existing knowledge and practice in the design and project management of space transportation systems. This present book is intended as a reference companion to the first book. The text discusses new conceptual changes in the design philosophy away from multistage expendable vehicles to winged, reusable launch vehicles and presents an overview of the systems engineering and vehicle design process as well as the trade-off analysis. Several of the chapters are devoted to specific disciplines such as aerodynamics, aeronautical analysis, structures, materials, propulsion, flight mechanics and trajectories, avionics, computers, and control systems. The final chapter deals with human factors, payload, launch and mission operations, and safety.


This is a compilation of 23 full-length, peer-reviewed papers, this volume explains the issues and current developments in the assessment of fatigue, brittle and ductile fracture. Topics covered include finite element methods; fatigue and fracture of nuclear components; and determining fracture toughness.


This is a compilation of 12 full-length, peer-reviewed papers. The volume is divided into the following four sections: effects on autofrettaged vessels—experimentation with the machining and diameter of a cross-bore, as well as with cracks in cylindrical vessels; analysis of methods used for vessel design; flaw evaluation and creep crack growth; and a panel discussion with members, Japan, Europe, and the US, to compare high pressure vessel codes.


This volume includes 33 full-length, peer-reviewed papers which fit into three broad categories: plastic analysis in pressure vessel design; environmental fatigue issues; and structural integrity of pressure components. Three panel sessions describe new developments in the ASME code and compliance with PED regulations.


This is a compilation of 48 full-length, peer-reviewed technical papers designed to advance current theory and practice of pressure vessels and components. The volume is divided into two sections: Design and analysis of pressure vessels, heat exchangers and components, and piping and components, including limit load analysis; and Fatigue and life assessment of compo- nents, new developments, simplified methods, re- actor vessel assessment. This section also includes Fitness for service: life extension, remediation, and repair.


This volume of 13 full-length, peer-reviewed technical papers covers measuring residual stress without the destruction of pressure vessels and piping. A sampling of contents includes stress measurement using x-ray diffraction and ultra- sound techniques; electromagnetic and holo- graphic techniques; speckle correlation interfer- ometry and local heat treating for low levels of stress; and testing of key mechanical properties of oil and gas pipelines.


This volume of 15 full-length, peer-reviewed papers covers the following topics: service expe- rience in operating nuclear plants; service expe- rience in fossil fuel plants containing strategies for assessing the degree of degradation in several critical components; weld residual stresses and fracture; and new cost-cutting weld models employing pre-machining and weld sequence design; and fabrication and performance.


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

V. MECHANICS OF FLUIDS


Reviewed by G de Vahl Davis (Sch of Mech and Manuf Eng, Univ of New South Wales, Sydney, NSW, Australia).

The finite analytic (FA) method is an Eulerian method that solves the differential equations for CFD/HT by representing the solution domain as a series of homogeneous, constant parameter elements. Within each of these elements an algebraic form of the analytic solution of a linearized form of the equations is constructed. The solution at a nodal value in the interior of each element is expressed as the sum of neighboring nodal values weighted by finite analytic coefficients. A system of these finite analytic algebraic equations is then solved to provide a numerical solution for the dependent variable at prescribed discrete locations within the domain.

The method was conceived by CJ Chen (one of the authors of this book) and his then student, Peter Li, in 1977. It was first published in 1981 and has since been developed, extended, and implemented by Chen, his students and others. A global web search for “finite analytic method” yielded about 200 hits, while ScienceDirect® (for Elsevier publications) yielded 96 references between 1980 and 2001. The method has been successfully applied to a range of problems in two- and three-dimensional flow and heat transfer, both laminar and turbulent, in regular and irregular domains. The authors claim that, compared to traditional finite difference (FD) methods, the method is stable and accurate over a much broader range of flow and computational parameters such as Reynolds number and grid spacing. Nevertheless, it has not yet been widely adopted, and several well-known texts on CFD/HT published in recent years do not mention it.

This book is aimed at graduate students and practitioners of CFD/HT. It is presented in five parts totaling 310 pages, comprising 25 chapters and two appendices. Some knowledge of differential equations and of some analytic methods are assumed.

Part I is entitled Introduction to Computational Fluid Dynamics and contains an introduction followed by chapters on Governing Equations (the N-S and energy equations and turbulence modeling); Classification of PDEs; Well-Posed Problems (including existence and uniqueness); Numerical Methods (a brief survey of FD, finite element (FE) and FA methods); and a more extensive chapter on The Finite Difference Method. In the chapter on numerical methods, the authors briefly compare FA with FD and FE, highlighting the advantages and disadvantages of each; they conclude, not surprisingly, that FA wins out.

In Part II, The Finite Analytic Method, the method is explained in detail. The seven chapters cover Basic Principles; One-, Two-, and Three-Dimensional Cases; Stability and Convergence; Hyperbolic PDEs; and what is called the Explicit Finite Analytic Method for the 2D transport equation for convection dominated flows, which is less complex than the implicit formulations developed in the preceding four chapters.

Part III, Numerical Grid Generation, contains an introduction covering algebraic transformations and a summary of different methods, followed by chapters on Elliptic Grid Generation; Equations in ξ and η Coordinates; Diagonal Cartesian (DC) Method; and FA Method on DC Coordinates.

In Part IV, several Computational Considerations are discussed: Velocity, Pressure and Staggered Grids; Nonstaggered Grid Methods; and Boundary Conditions.

Finally, Part V describes some Applications of the FA Method to Turbulent Flows; Turbulent Heat Transfer; Complex Domain Flows; and Conjugate Heat Transfer. It is this section, more than any other, which will allow teachers and practitioners to decide whether to adopt the method. The examples include turbulent flow past disc valves; the sea breeze phenomena (sic), a turbulent atmospheric boundary layer circulation driven by surface temperature gradients; groundwater flow and solute transport; and the design of a compact heat exchanger.

The authors say that a 2D laminar Fortran code is available at www.finiteanalytic.com. However, when this reviewer went there, he got the message “This site is currently under construction; please check back at a later time” in several languages.

This book should certainly be seriously considered by teachers of CFD/HT, and graduate students should have some exposure to the ideas presented. Time will tell whether the finite analytic method will take a place alongside—or perhaps even surpass—finite difference and finite element methods.


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

Laminar boundary layer theory, as taught in most introductory fluid mechanics courses, involves asymptotic expansion of the Navier-Stokes equations to leading order in a small parameter equal to the minus one-half power of the Reynolds number. An inner viscous region (the boundary layer) and an outer inviscid region are matched to one another to fix the unknown terms in the expansions. Boundary layer theory at this order works very well for many engineering applications; it is, however, inadequate for the prediction of some very important phenomena, particularly in relation to flow separation.

If the asymptotic expansions are carried to higher order, difficulties arise in the form of singularities and an inability to match the higher-order terms. These problems were explored in detail by Goldstein and others, beginning in the 1930s. Only in 1969 was a resolution found, in the form of interactive boundary layer theory. To what interaction does this name refer? Specifically, it is an interaction between the pressure field and the streamline displacement, which is accommodated by a three layer, or triple deck, analysis of the boundary layer.

Sobey’s new monograph, Introduction to Interactive Boundary Layer Theory, is an effort to collect and summarize the fundamental developments in this very abstruse area of fluid dynamics. His approach is initially historical. After a short chapter recapitulating the equations of fluid dynamics, Sobey begins serious work with a 50-page summary of theoretical efforts to take boundary layer theory to higher order. These efforts focused on the simple situations of semi-infinite and finite length flat plates. Sobey thoroughly illustrates problems encountered by Goldstein and others as they attempted to complete a second-order theory, and he shows how a severe singularity in transverse velocity arises at the trailing edge of a plate.

The third chapter gives an account of the triple-deck theory, through which Stewart-
son and Messiter independently resolved the trailing edge singularity in about 1969. Their work introduced a three-layered structure near the trailing edge of a plate, each layer of which scales with a different power of the Reynolds number. The analysis is executed through multiple matched asymptotic expansions. The numerical solution of the resulting equations is described in Sobey’s next chapter. The triple-deck model successfully resolves the trailing-edge singularity found in the classical two-layer theory, and, in the author’s estimation, is “one of the outstanding achievements in theoretical fluid mechanics.”

In Part II of the text, Sobey turns to the problem of separated flow. After a brief introductory chapter, he devotes Chapter 6 to a historical survey of efforts to predict separation in crossflow over a cylinder. Free streamline theories, boundary layer theories for adverse pressure gradients, and combinations thereof are summarized through the year 1969. Chapter 7 describes efforts to use triple-deck ideas for this problem and outlines some of the continuing difficulties with the theory.

The final part of the book, in three chapters, applies interactive boundary layer theory to two-dimensional channel flows in which the walls are perturbed by indentations. Upstream influence and the Coanda effect are each considered at length. An Appendix provides problems and numerical exercises.

This book is not for the faint of heart. A working knowledge of asymptotics is essential, as is a thorough acquaintance with classical boundary layers and potential flow theory. For those having such a background, the mathematics will still demand careful reading. Of course, one of the rewards of having learned the classical theory is that a book like this one is both accessible and rewarding. On the other hand, despite the hopeful statement in the preface that readers with little background in fluid mechanics should be able to absorb the text, nonspecialists will find this material challenging.

The major flaw of the book is a lack of careful proof reading, as in the following passage from page 30:

“This factors of v2 which appear in (2.25) are somewhat arbitrary, different authors have used slightly differing notation, in this case we are following Van Dyke (1964).”

Such phrasing permeates the text and poses an ongoing distraction. Sobey often moves to an imperative voice when introducing equations or procedures (“Now expand...” “Define parabolic coordinates by...”), which creates the sensation of notes copied onto a chalkboard. Finally, although the book is typeset in LaTeX, the latter has not been used to its full potential. The delimiters in many equations are not sized properly, and the frequently-used symbol for “much less than” is set as < <, rather than via the glyph \ll (obtained with the LaTeX “amssymb” package).

These concerns are, of course, minor; Introduction to Interactive Boundary Layer Theory will stand as a unique and valuable contribution to the literature. Students of theoretical fluid mechanics have much to gain from this book.


This is the first book, to my knowledge, to give a detailed description of the basic physics and mathematics of pulsatile flow in a tube. While the focus of the monograph is the physics and mathematics of pulsatile flow, the author does refer often to the application of this knowledge to the subject of blood flow in the conduits of the mammalian circulatory system. There are two monographs that write on this subject from a medical perspective (Hemodynamics, by WR Milnor, and Blood Flow in Arteries, by DA McDonald) and two monographs that give a broader view of the physics of circulation (The Fluid Mechanics of the Large Blood Vessels, by TJ Pedley, and Biodynamics—Circulation, by YC Fung). Finally, there is a non-mathematical, but highly descriptive monograph on this subject (Vital Circuits, by S Vogel).

The six chapters of the present book may be divided into two categories: Chapters 1 and 2 focus on fundamental concepts and Chapters 3 through 6 describe four cases of tube flows. The first chapter of the book provides a presentation of the background concepts that are required to study tube flows. This reviewer was pleased to find that, in addition to the required basic concepts, the author has included a section on whether or not blood may be treated as a Newtonian fluid. He also provides a brief discussion on when blood flow might be turbulent. The second chapter is a standard development of the equations of motion for fluid flow—the author derives the equations in polar cylindrical coordinates so they may be readily applied to tube flow.

Chapter 3 focuses on the subject of steady tube flow. The Hagen-Poiseuille solution is developed and discussed. The author goes on to discuss entry length of a tube flow and then devotes the remainder of the chapter to the application of modeling flow in the arterial tree. The chapter has an insightful discussion of the concept of the energy expenditure that is required to move a fluid through a tube and the implications of this on the diameter of blood vessels in the arterial tree. One area for improvement in this chapter and throughout the book would be the addition of a few examples with realistic numerical values for viscosity, diameter, etc. The reader would then get an idea of the order of magnitude of quantities that are being discussed (for example, does it require 1 watt or 100 watts to pump blood through the human aorta at typical conditions?).

Chapter 4 goes on to consider the case of pulsatile flow in a rigid tube. The author presents a detailed development of the solution for the case of a flow driven by a purely sinusoidal pressure waveform. He includes a section on how Fourier analysis can be used to represent waveforms that are more complicated than a simple sine wave (such as the waveforms that occur in the flow of blood in the arteries). The author presents graphical results of the velocity profiles. This reviewer was surprised that the author did not present and discuss the near-wall velocity overshoot (Richardson’s annular effect) that is a hallmark of oscillatory tube flow. On the other hand, this reviewer compliments the author for his unique contribution in writing an entire section on the power required to drive a pulsatile flow. Chapter 5 gives a clear and unique presentation of the analysis and results for pulsatile flow in an elastic tube. Chapter 6 presents the theory of wave reflection for pulsatile flow in a system of elastic tubes. Both Chapters 5 and 6 include a level of detail that is not found in other books.

On the whole, this reviewer found the topics in this book to be presented with clarity. The unique features of the monograph include the presentations on pumping power and the level of detail in the presentations on flow in an elastic tube and on the theory of wave reflections. The author has chosen to limit the book’s scope—he does not address the secondary flow patterns that develop at bends, bifurcations, constrictions, or other morphologies that exist in the cardiovascular system. The author has included excellent problems at the end of each chapter, solution summaries at the end of the book, and a valuable list of references with each chapter. This reviewer is pleased to recommend Physics of Pulsatile Flow for the library of anyone involved in the study or teaching of internal pulsatile flows.
Chapter 9 considers ideal inviscid flows. In the first part, the Euler equations along streamline coordinates and the Bernoulli equations are discussed, while in the second part, the basic theory for two-dimensional potential flow is introduced. No mention is made of the three-dimensional potential flows.

The successive four chapters present additional material which could be taught as complementary material in a course. Chapter 10 deals with the dynamics of rotating fluids and turbo-machinery starting from the conservation of angular momentum for closed and open systems. Partial examples are then illustrated showing pumps, turbines, and propellers.

Chapter 11 describes compressible flows starting from the speed of sound up to normal and oblique shocks and expansions. At the end of the chapter, Rayleigh and Fanno flows are described. In Chapter 12, some basic concepts of experimental fluid dynamics are given by describing the main components of a data acquisition system and the main measurement techniques. The last chapter provides the fundamentals of computational fluid dynamics with solution schemes for algebraic, ordinary differential, and partial differential equations. Finally, simple techniques for the solution of viscous and inviscid flows are yielded.

The five appendices contain, respectively, fluid properties, compressible flow tables, differential form of the equations in Cartesian, cylindrical-polar and spherical coordinates, and some simple computer programs and background material (such as vector and tensor algebra and elementary calculus) for a better comprehension of the material in the book.

This reviewer believes that the quality of the book is adequate for the intended scope. The presented material is well explained and completed with a lot of examples whose solution can be used as a guideline for the numerous exercises at the end of each chapter. Many good-quality pictures contribute to make the exposition clear and pleasant.

In conclusion, *Principles of Fluid Mechanics* is suitable for adoption as a text for the undergraduate level. Concerning libraries, it could complete the existing literature for undergraduates providing an additional viewpoint.


This proceedings volume, like the conference, aims at providing a comprehensive survey of the current status of research, development, and application in all disciplines of aerodynamic drag reduction including laminar flow technology, adaptive wing concepts, turbulence control, induced drag reduction, and super-sonic flow aspects. Most of the papers presented at the conference are included in this volume.


“Granular gases” are dilute granular systems, i.e., many-particle systems, in which the mean free path of the particles is much larger than the typical particle size. This condition implies that the duration of particle contacts is much shorter than the mean flight time. In contrast to molecular gases, in granular gases the particle collisions occur dissipatively, i.e., in each binary collision the particles lose part of the kinetic energy of their relative motion. The dissipation of kinetic energy causes a series of non-trivial effects, such as the formation of clusters and other spatial structures, non-Maxwellian velocity distributions, anomalous diffusion, correlations in the velocity field, characteristic shock waves, and others.

This book is divided into five sections on the following topics: Kinetic theory and hydrodynamics, Collisions and one-dimensional models, Vibrated granular media, Granular astrophysics, and Towards dense granular systems. Each section contains four to seven individually-authored investigation results. An author index is also provided.


This proceedings includes seven Keynote Lectures, 47 papers, and 17 poster session papers from the 2nd International Conference on this topic. It covers the areas of two-phase flow and transport phenomena.


This proceedings contains 7 invited and 118 contributed papers divided into the following 13 chapters: Kinetic theory and transport phenomena; Rarefield flow studies; Plasma flows and processing; Numerical methods; Gas-surface interactions; Particle models and processes; Microscale flows; Multiphase flows; Chemical reactions and thermal radiation; Low density aerodynamics; Jets, plumes, and propulsion; Clusters, aerosols, and granular gases; and Internal flows and vacuum systems.
VI. HEAT TRANSFER


This well-written book is a useful addition to the large number of textbooks available for heat transfer courses that are taught at the undergraduate level in engineering. It is written as an introductory book for a one-semester course, though the material included is more than what can easily be covered in a semester. It is written in a clear and easy-to-understand style, with a focus on the basic principles of heat transfer. Consequently, advanced topics, solution methods, and applications are generally not covered, since the basic concepts can be brought out by considering relatively simpler problems. Though the emphasis is on analysis, some discussion is devoted to numerical methods, and a few selected computer programs are included. The book stresses problem formulation on the basis of the fundamental principles of thermodynamics and mechanics.

The book starts with the foundations of the subject and discusses the basic concepts that are used for formulating a problem in heat transfer. The basic laws such as Fourier's law of conduction and Stefan-Boltzmann's law of radiation are presented in Chapter 1, including the inductive formulation approach being introduced in Chapter 8, including the inductive formulation approach being used for obtaining the solutions. Thus, the treatment, and both steady and unsteady problems are considered for a numerical solution. This chapter shows the importance and usefulness of numerical methods and presents some standard solution strategies.

The basic concepts in convection, including boundary layer flow, dimensional analysis, scales, dimensionless parameters, and governing equations, are presented in Chapter 5. The integral analysis approach is used for obtaining the solutions. Thus, the treatment is somewhat elementary, but it does bring out the basic features of the transport processes. The discussion is mainly directed at the physical nature of the problem and underlying principles, as done earlier for conduction. This is followed, in the next chapter, by empirical correlations for both forced and natural convection. Many important results, with some presented in terms of dimensionless numbers proposed by the first author, are given. The use of these correlations is also demonstrated. The analysis and selection of heat exchangers are discussed in detail in Chapter 7, considering different types of heat exchangers and methods of analysis. Important and well-known results are included.

Radiation heat transfer is covered in the next three chapters. The basic concepts are introduced in Chapter 8, including the quantum mechanics basis for transport and properties of radiation. This is followed by a chapter on radiative exchange in enclosures using view factors, electrical analogy, and the radiosity method of analysis. Gas radiation is presented in the next chapter considering radiation properties of gases, optical thickness, and simple methods to account for gas radiation. This chapter presents several useful results that can be used in practical problems. Finally, phase-change problems are considered in the last chapter. Several interesting results in boiling and condensation are given. Some important material properties, units, charts, and correlations are included in the appendixes making it easy to find relevant data for solving exercises in the book.

The presentation is clear, and the treatment is quite satisfactory for an introductory course. It will be a useful textbook for engineering students who have not studied heat transfer, though they have been exposed to courses in thermodynamics and fluid mechanics. Most other textbooks in heat transfer at this level tend to focus on solution methods and results, while also discussing various practical problems to bring out the importance of heat transfer in different fields. The present book is clearly directed at the fundamental aspects and on the formulation of the problem. It serves a very useful and worthwhile role in this capacity. The examples and exercises given in the book help in the presentation and in the understanding of material, as well as in pointing out the application of these methods to more complicated problems. Intro-
duction to Heat Transfer can certainly be recommended as a textbook for introductory courses in heat transfer.


This proceedings includes most of the papers presented at the conference. A total of 72 papers from 18 countries are divided into the following sections: Slit heat transfer and fundamental studies; Single-phase augmentation techniques; Single-phase design data and methods; Single-phase heat exchanger development and applications; Phase-change heat transfer fundamental studies; Vaporization, condensation, and absorption augmentation techniques; Vaporization and condensation design data and methods; Phase-change heat exchanger development and applications; and Fouling in heat exchangers.

These papers represent a focused attention to the use of CHEs and Enhancement Technology in the process industries and indicate opportunities in the process industries.


This volume includes most of the contributions at the workshop which was designed to review the present status of turbulent combustion studies. Ten papers describe the latest findings of Japanese studies in this field.


VII. EARTH SCIENCES


This volume contains 57 articles showing the state of the art in the field of porous media research. It provides the whole range of modeling empty, partially-saturated, and fully-saturated porous materials, such as soil, concrete, sinter materials, metallic and polymeric foams, glacier and rock ice, living tissues, etc. In addition to the macroscopic continuum mechanical view of porous materials and the numerical computations of fully coupled solid-fluid problems, micro- to macrohomogenization strategies are presented and material parameters are compared to experimental data to optimize the geometrically linear and finite approaches for the description of the elastic, viscous, and plastic properties of the solid matrix and the viscous properties of the pore-fluids. In addition to these general topics, several contributions are included concerning the field of wave propagation, localization phenomena, Biot’s approach to porous media, fracture and damage, swelling, drying and shrinkage, as well as composite materials.

This book allows researchers and engineers to get an overview of the theoretical and numerical description of porous materials, including various applications to practical engineering problems.


This is a collection of 35 full-length, peer-reviewed technical papers covering the following broad topics: high-level seismic response of piping; seismic evaluation of systems, structures, and components; seismic structure response and interaction effects; seismic, shock, and vibration isolation; and seismic testing and analysis verification.


This collection of 16 full-length, peer-reviewed technical papers covers earthquake damages and earthquake ground motions, control with active and passive dampening, and innovative anti-seismic techniques. The winning paper from this Student Paper Competition is also published in this book.


Reviewed by SA Sheriff (Dept of Mech Eng, Univ of Florida, 228 MEB, PO Box 116300, Gainesville FL 32611-6300).

This book is intended for use as a textbook for upper level undergraduate and graduate courses in groundwater hydrology, groundwater hydraulics, and mass transport of subsurface contaminants. It is also intended to serve as a reference for practicing hydrologists, hydrogeologists, and environmental engineers. The book contains nine chapters, nine appendices, 460 references grouped at the end of the book, and an index.

Chapter 1 is an introduction to groundwater hydrology with topics dealing with porous media, distribution of subsurface water, porosity and related properties of soil, subsurface hydrologic cycle, and hydrologic logic. Chapters 2 presents a discussion of Darcy’s Law, continuity relations for flow in porous media, and groundwater management models. Chapter 3, entitled Groundwater and Well Hydraulics, addresses topics such as steady and transient flow to a well in an ideal confined aquifer, pumping tests, slug tests, well tests, multiple well problems, potential flow for stratified aquifers, the interface in coastal aquifers, and other transient flow problems. Chapter 4, entitled The Vadose Zone and Groundwater Recharge, presents detailed discussions of soil water in the vadose zone, soil water characteristic curve, Darcy’s Law and Richard’s Equation, measurement of soil properties, infiltration models, redistribution of soil water, evaporation and desorption models, evaporation from a shallow water table, and water balance and groundwater recharge.

Chapter 5 deals with sources of subsurface contamination, mass transport processes, the general continuity equation, solute partitioning, degradation losses of soil and groundwater contaminants, and simplified forms of the continuity equation. Chapter 6 entitled Solute Transport by Advection, includes topics such as advection transport, potential theory, potential and stream functions, some applications of potential theory, residence time distribution theory, standard flow patterns, and evaluating the environmental consequences of groundwater contamination. Chapter 7 is entitled Solute Transport by Diffusion and deals with Fick’s laws, molecular diffusion coefficients, diffusion in porous media, diffusion in multiphase systems, some applications of the diffusion equation, and volatilization losses of soil contaminants. Chapter 8 presents detailed discussions of one-dimensional flow and column experiments, radial flow from a well, transverse dispersion, the mechanical dispersion tensor, moments of the transport equation, analytical models of chemical spills and contaminant plumes, numerical simulation of solute transport, nonideal flow in porous media, and subsurface mass transport through the vadose zone. Chapter 9 deals with multiphase flow and hydrocarbon recovery. This includes topics such as capillary trapping and residual saturation, NAPL behavior in fractured media, monitoring of free-product petroleum hydrocarbon, NAPL infiltration in the vadose zone, screening models for fate/transport of organic chemicals in soil and groundwater, soil-vapor extraction systems, and free product recovery of petroleum hydrocarbon liquids. Many of the appendices have spreadsheet modules for topics discussed in the book. Examples include modules for calculating well functions, slug test well function, LNAPL distribution, and LNAPL recovery analysis.

Groundwater Hydraulics and Pollutant Transport is very well written and organized, contains topics appropriate for its
IX. BIOENGINEERING


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

This is a tutorial intended for beginning students who are considering careers in bioengineering. The objective is to provide readers with a view of contemporary studies in bioengineering and to thereby create an inventive/design motivation for further studies. As a course text, however, this book is quite different from traditional textbooks: It is written by 12 authors (mostly from the University of California at San Diego) and divided into 11 chapters on a variety of topics. In each chapter, the author (or authors) provide a relatively informal or conversational perspective on the chapter topic which is then followed by a contemporary archival research paper (or papers). The pedagogic is to get the readers a broad introduction followed by detailed in-depth analyses. A series of assignments and special projects are also provided.

The text spans approximately 285 pages. The chapter topics and authors are: Roles of flow mechanics in vascular cell biology in health and disease, by Shu Chien; Perspectives of biomechanics, by Yuan Cheng Fung; Implantable glucose sensor: An example of bioengineering design, by David A Gough; Design and development of artificial blood, by Marcos Intalietta; Analysis of coronary circulation: A bioengineering approach, by Ghassan S Kassab; What lies beyond bioinformatics, by Bernhard Palsson; Tissue engineering of articular cartilage, by Robert L Sah; Cell activation in the circulation, by Geert W Schmid-Schonbein; Molecular basis of cell membrane mechanics, by Lanping Amy Sung; Biomechanics of injury and healing, by Pin Tong and Yuan Cheng Fung; and Pulsatile blood flow in the lung studied as an engineering system, by Michael RT Yen and Wei Huang.

The editor has successfully kept the contributions relatively uniform in style and in level of content. The subject areas, however, are less well distributed, but instead they tend to emphasize fluid mechanics and microbiomechanics as opposed to solid mechanics (skeletal biomechanics) and dynamics (kinesiology). Interestingly the authors admit this imbalance, but they nevertheless seek to meet the stated tutorial objectives. They appear to be successful. Indeed, in this reviewer’s experience, the approach taken here seems to be very effective in both introducing students to the subject and for motivating further study in a field which encompasses all of applied mechanics and much more.

This reviewer finds Introduction to Bioengineering to be a new and refreshing text on this increasingly evolving subject. Critically, it would be easy to identify some chapters as being more interesting and more attuned to the objectives than others. But this would not make the book any less attractive. The only serious criticism is that the book has no index, glossary, or bibliography.

Adoption consideration by introductory bioengineering course instructors is strongly recommended.


Reviewed by RL Clark (Dept of Mech Eng and Mat Sci, Duke Univ, 301 Hudson Eng Center, PO Box 90300, Durham NC 27708).

The introduction of this text is timely with regard to current interest in nanoscience and nanobiomechanics. A recent article, “The Little Engines That Couldn’t,” (Peter Weiss, Science News, July 22, 2000), reveals that “early enthusiasts didn’t anticipate the powerful forces that arise at the surfaces of micromachines.” In particular, components of such devices intended to move, such as miniature gears in micro-electro-mechanical systems (MEMS), tend to stick together because of van der Waals and other molecular forces. This problem results from attempts made to “miniaturize” conventional engineering systems without consideration of changes in forces that dominate at these different scales (inertial versus viscous for example). In contrast, nature scales up when “engineering” systems and works within an aqueous environment for the most part. This textbook provides a wonderful perspective for mechanics at the scale of a single protein molecule where dimensions are measured in nanometers and forces are measured in picoNewtons.

The author of this text does an outstanding job in developing a book for a broad audience, inclusive of biologists, physicists, and engineers. The book is aimed at an introduction to the mechanics of molecules and the application of this knowledge to the morphology and motility of cells. This aim is readily achieved within this text, which is well suited as an introductory graduate course for the intended audience.

The book is well organized into three primary parts: Physical Principles, Cytoskeleton, and Motor Proteins. If an engineer is interested in nothing more than gaining insight into the relevant physics at the molecular level, then the book is worth purchasing simply for the well-written section devoted to Part I: Physical Principles. Within this section, mechanical forces; mass, stiffness, and damping of proteins; thermal forces and diffusion; chemical forces; and polymer mechanics are all discussed. The mathematical treatment within the chapters is sufficient to provide perspective; however the specifics of the mathematical developments are detailed for the reader with more inclination for such in the appendices.

The author does an outstanding job in providing figures that readily convey the pertinent concepts. Furthermore, there are numerous examples which succeed in conveying insight into the mechanics at the molecular scale as well as perspective of dimensional units. These examples provide a much needed bridge between the terminology used in biology and that used in engineering.

Part II and Part III of the text provide context for the structure; mechanics, and polymerization of cytoskeleton filaments and also provide specifics of force generation and active polymerization. This is essential background for detailing the structure of the motor proteins, including parameters such as speed, steps, and forces. The operation of these nanomachines, manufactured by nature, provides much motivation and insight for engineers.

Mechanics of Motor Proteins and the Cytoskeleton will take permanent residence on this reviewer’s shelf due to a personal interest in mechanics at this scale, and this reviewer would highly recommend it to those with an interest in the currently investigated area of the analysis or development of micro-electromechanical systems or nano-electro-mechanical systems.

X. GENERAL & MISCELLANEOUS


The purpose of this handbook is to present the reader with a teachable text that includes theory and examples. Useful analytical techniques provide tools for mechanical design. The book may also serve as a reference for the designer, a source book for the researcher, and a guide for the mechanical engineer. It covers a broad spectrum of critical engineering knowledge. This handbook contains the fundamental laws and theories of science basic to mechanical engineering including controls and mathematics and provides suggestions for more specific literature.
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