BOOK REVIEWS

I. FOUNDATIONS & BASIC METHODS

7R1. Boundary Element Methods for Engineers and Scientists: An Introductory Course With Advanced Topics.- Edited by L Gaul *(Inst A of Mech, Univ of Stuttgart)*, M Kogl *(Dept of Struct and Found Eng, Univ of Sao Paulo, Brazil)*, and M Wagner *(BMW Group, Munich, Germany)*. Springer-Verlag, Berlin. 2003. 488 pp. Hardcover. ISBN 3-540-00463-7. $79.95.

Reviewed by Jeng-Tzong Chen (Dept of Harbor and River Eng, Natl Taiwan Ocean Univ, PO Box 7-59, Keelung, Taiwan 202, ROC).

As the title of this book emphasizes, an introductory course to the boundary element method (BEM) and advanced formulations is presented. The book contains four parts: Part I: The direct Boundary Element Method, Part II: Dual Reciprocity method (DRM), Part III: Hybrid Boundary Element Methods, and Part IV: Appendix.

Part I can be seen as an introductory course, while Parts II and III cover advanced topics that contain the authors' research material. The appendices in Part VI contain some fundamental solutions and particular solutions for the DRM. Exercises and programs are not provided. The reviewer found that an on-line book of BEM by the first author is available on the web site of http://www.bem.uni-stuttgart.de/. This site provides a more friendly and suitable textbook for beginners since exercises are given.

As it is common with other BEM books, this text begins with an introduction and mathematical preliminaries. A special chapter on continuum physics is added in Chapter 3: The basic laws and constitutive equations for elastodynamics, heat conduction, eletrodynamics, thermoelasticity, acoustics and piezoelectricity are covered to provide a complete overview on the physical modeling. Chapters 4 and 5 introduce the direct BEM for potential problems of the Laplace and Navier equations with emphases on the issues of anisotropy and piezoelectricity. No indirect formulations in terms of single-layer or double-layer representations are developed. Numerical integration schemes for regular and singular integrals are addressed in Chapter 6.

Part II and III on advanced topics include the dual reciprocity BEM and the hybrid BEM. Chapter 7 basically follows the DRM book by Partridge *et al*, for a general introduction to the method. Chapter 8 focus on the solution of the DRM equation of motion and Chapters 9 and 10 present the application of the DRM to piezoelectricity and thermoelasticity.

The hybrid BEM is derived from variational principles of mechanics that are reviewed in Chapter 11. Hybrid displacement and hybrid stress methods are both addressed in Chapter 12 and 13, respectively. Since the presented hybrid BEM uses the same source of variational principles as for hybrid FEM, one obtains symmetric system matrices. In contrast to symmetric Galerkin BEM, the hybrid BEM does not require a double integration over the boundary.

Although *Boundary Element Methods for Engineers and Scientists: An Introductory course with advanced topics* can be used as a text in a BEM course, it contains some original results regarding the dual reciprocity BEM and the variational formulation of the hybrid BEM. The book is thus recommended to graduate students and engineers. The authors have succeeded in fulfilling their aim of a dual-purpose textbook. In Part I, students as well as practitioners find a clear introduction to the method, whereas Parts II and III can serve as a valuable reference to researchers and engineers. The main distinction of the book in comparison to available works on the BEM may be its focus on the application of the method to anisotropy, piezoelectricity and thermoelasticity, as well as the presentation of the hybrid BEM. The book contains 488 pages with 135 figures. The quality of print and figures is adequate. In general, this is a well-written book and is recommended to individuals and libraries.

7R2. An Introductory Guide to Finite Element Analysis.-Edited by AA Becker *(Dept of Mech Eng, Univ of Nottingham)*. ASME International, New York. 2004. 171 pp. Hardcover. ISBN 0-7918-0205-1. $79.00.

Reviewed by D Karamanlidis (Dept of Civil Eng, Univ of Rhode Island, Bliss Hall, Kingston RI 02881).

As anyone who ever taught or took a course on finite elements will attest, there is no short supply on introductory texts on Finite Element Analysis (FEA). In fact, there must be over a hundred such texts currently in print and several of them are nothing short of excellent. On the top of this reviewer's list are (in no particular order) Segerlind, Huebner, Bathe, and Wilson, Gallagher, Yang, Desai and Abel, and others. Thus, with so many good books to choose from the following question arises: What does a new FEA text need to offer in order to have a chance against all these well-established, time-honored heavyweights? The key, in the opinion of this reviewer, is pedagogy. Present the subject in such a way that today's undergraduates (with a relatively limited experience in math and mechanics) can grasp the salient concepts behind the method.

According to the preface, ''the book is suitable both for beginners and those seeking to strengthen their background knowledge of FE methods.'' It is broken down in ten chapters, namely: 1) Introduction and background, 2) Structural analysis using pin-jointed elements, 3) Continuum elements, 4) Energy and variational principles, 5) Higher order quadratic elements, 6) Beam, plate, and shell elements, 7) Practical guidelines for FE applications, 8) Introduction to nonlinear FEA, 9) Thermal Problems, 10) Examples of FE applications. Chapters 1 through 9 contain a combined total of three (3) examples and not a single assignment problem.

Now taking a closer look at the contents, one is puzzled by the sheer volume of omissions, misrepresentations and confusing statements that made the final print. Some examples are listed below:

Page 9, Strain Energy: Concerning the formula, in Equation (1.14) the integration symbol is missing and should be replaced by. In the next equation on the same page, the factor 1/2 is missing.

Page 14: In both equations (1.30) and (1.31), the factor 2 is missing in front of the shear terms.

Pages 17 and 19: Equation (2.2) states that the axial strain for a rod is given by whereas Equation (2.13) leads to.

Page 19: With reference to the two-noded truss element, it stated that ''such an element is said to have one degree of freedom.'' Actually, the element is known to have two degrees of freedom (=independent displacements), namely u1 and u2.

Page 26: Concerning the stiffness matrix for the two-noded truss element using global displacement variables, it is stated that it is derived by taking the partial derivatives of the strain energy in terms of the four global displacements. Since these four variables are linearly dependent, the above operation is not permissible.

Boundary Conditions: The reader comes away with the impression that first the global stiffness matrix is assembled and then the boundary conditions are imposed. Actually, it is common practice to impose the boundary conditions *on the fly* during the assembly thereby avoiding the need to unnecessarily inflate both the size of the glo-

bal equations and the computational effort to solve them (cf, Bathe and Wilson, to name but one source).

Continuum Elements: Only the stiffness matrix for the time-honored but nowadays rarely used CST element is presented. Nothing about quadrilateral elements, not to mention isoparametric elements. This is a bit strange, because the results presented in Chapter 10 were actually produced using isoparametric elements.

Page 57: With reference to solutions obtained using Ritz method, it is stated that ''the above exact solution is different from all the trial solutions used above.″ Actually, Equations (4.21) (trial solution) and (4.24) (exact) are identical.

Beam Element: The beam shape functions may be written down directly as Hermitian polynomials. There is no need to invert any 4×4 matrices to obtain them. It's not clear to this reviewer why not a single example was presented to showcase the element's use.

Plate/Shell Elements: Given the fact that these are the most widely used elements, it's not clear why only the special cases of axisymmetric elements (which are very similar to the previously presented beam and truss elements) are mentioned.

Further, the choice to include a superficial at best coverage of nonlinear FEA (let's face it: others have devoted to the subject two volumes double the size of the present one) instead of more *down the earth* topics such as buckling and free vibrations) appears to be a curious one.

In conclusion, it is the opinion of this reviewer that *An Introductory Guide to Finite Element Analysis* suffers from too many deficiencies to be considered suitable reading both for beginners and those seeking to strengthen their background knowledge of FE methods. Students and instructors interested in FEA will be better off sticking with the *classics* mentioned previously.

II. DYNAMICS & VIBRATION

7R3. Waves in the Ocean and Atmosphere: Introduction to Wave Dynamics.- Edited by J Pedlowsky *(Dept of Physical Oceanography, Woods Hole Oceanographic Inst, Clark 363 MS 21, Woods Hole MA 02543).* Springer-Verlag, Berlin. 2003. 260 pp. ISBN 3-540-00340-1. $49.95.

Reviewed by JW Miles (Inst of Geophysics and Planetary Phys, UCSD, 9500 Gilman Drive, Mail Code 0225, La Jolla, CA 92093-0225).

This book, the author informs us, was developed as a set of lecture notes for one of a series of core courses in geophysical fluid dynamics and physical oceanography at MIT and Woods Hole over more than twenty years. One recalls that its eminent relative, Geophysical Fluid Dynamics, was developed for a (presumably) similar core curriculum at the University of Chicago, but the two books differ in both style and depth. Geophysical Fluid Dynamics is a classic that merits a prominent place on the bookshelves of everyone working in the field; the present book serves the student well but is much less likely to be consulted by the working scientist or cited as a standard reference.

Pedlosky begins with two chapters (''lectures'') on kinematics that introduce dispersion and group velocity. He then goes on to develop the equations of motion for surface gravity waves and to discuss energy propagation. Against this basic background, he devotes four chapters to internal gravity waves and, in the remaining two-thirds of the book, deals with waves for which rotation of the Earth plays an essential role. Among the topics covered are Rossby waves, the beta plane (both non-equatorial and equatorial), quasigeostrophic motion, potential vorticity, the WKB approximation, baroclinic instability, topographic waves, and wave-mean-flow interactions. He concludes with twelve problem sets and a list of references grouped by chapter. The exposition is leisurely and informal, with frequent sotto-voce instructions and remarks, and is accompanied by a generous supply of simple but informative diagrams.

Several topics that one might expect to find in a course on water waves—eg, solitary waves, tsunamis and tides—are absent. There is, to be sure, a chapter titled ''Laplace Tidal Equations'', but the tides themselves are not discussed. On balance, however, the coverage and topical selection for the student of geo-physical fluid dynamics are excellent.

The question remains: would you choose waves in the ocean and atmosphere: Introduction to Wave Dynamics for a first-year course on atmospheric and ocean waves? Some might be put -3 -off by the quasi-colloquial style (or prefer their own quasi-colloquial style), but others will find it refreshing. And, given the stated purpose of the book, qua elementary text, I know of nothing that can match it.

III. AUTOMATIC CONTROL

7R4. Fundamentals of Robotics: Linking Perception to Action. Series in Machine Perception and Artificial Intelligence.–Edited by Ming Xie *(Singapore–MIT Alliance, Singapore*). World Sci Publ, Singapore. 2003. 692 pp. ISBN 981-238-313-1.

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

This book is probably best described as a contemporary reference describing the state-of-the-art of robotics, at this time. It is a truly impressive volume where the author documents the many significant robotic advances during the last quarter century and also looks to the future.

The book discusses the broad range of robotics technology ranging from mechanical considerations, to electrical and electronics devices, to control, to vision, to decision-making and artificial intelligence. The book is intended for students, for those just getting started in the field, and for experienced practitioners.

The book has three underlying themes: 1) A presentation of the fundamental underlying physics and associated analytical procedures; 2) Thinking of robotics from a systems perspective; and 3) Treating the entire subject tutorially. Throughout the book the author presents the physical principles, the mathematical analysis, applications, and illustrative examples. In many instances he provides extensive explanations of particular aspects of the technology, including design considerations. At all times, the focus is upon viewing a robot as a complex system incorporating a wide variety of technologies, but principally electro-mechanical-control and decision making.

The book itself is divided into nine chapters spanning approximately 700 pages. Chapter 1 provides a brief introduction to the subject outlining the various applications of robots ranging from the industrial/manufacturing setting to the household environment. Contained therein is an interesting discussion about humanoid robots. The author also summarizes the principal issues and problems in robotics technology.

The second and third chapters are devoted to mechanical issues such as kinematics (position displacement, rotation, and velocity), mechanisms, joints, and chains. Both forward and inverse kinematics is discussed. The fourth chapter then considers robot dynamics, motors, and drive devices.

Control issues are studied in Chapter 5. The ensuing topics include automatic feedback systems, control elements, sensing elements, design consideration, algorithms, and joint-, task-, and image-space control.

In the next three chapters the author discusses information systems, visual sensory systems, and visual perception systems of robots. Chapter 9 is devoted to decision-making, including issues of planning, mapping, constraints, and control. The book concludes with a very brief chapter on future expectations.

Each chapter contains examples, exercises, and a bibliography.

The author is to be commended for the ambitious undertaking of trying to incorporate all these topics into a single volume. The finished product is impressive. The writing is good and the examples are clear and informative. There are of course many

places where prior knowledge and expertise are needed to fully benefit from the discussion. On balance, however, *Fundamentals of Robotics: Linking Perception to Action* should be of interest and use to those either working in robotics, hoping to enter the field, or those simply having a curiosity about the subject matter. Purchase is recommended both for individuals and libraries.

IV. MECHANICS OF SOLIDS

7R5. Smart Technologies - Edited by K Worden, WA Bullough, and J Haywood *(Univ of Sheffield, UK).* World Sci Publ, Singapore. 2003. 271 pp. ISBN 981-02-4776.1.

Reviewed by FM Casciati (Dept of Struct Mech, Univ Pavia, Via Ferrata 1, Pavia I27-100 Italy).

Smart Technologies is the title of a volume edited by Worden, Bullough, and Haywood, three researchers active at the Dynamic Research Group of the University of Sheffield, UK. The first editor signed, with the other two colleagues, the introductory Chapter 1, but he is also one of the two co-authors of Chapter 4 on Data Fusion. The second editor is also the author of Chapter 8 on Smart Fluid Machines. The book should be a good reference for a reader looking for a quick informative.

As detailed by the editors in Chapter 1, the book consists of nine short monographic contributions, in 271 pages, written by internationally recognized experts in their specific field:

- Culshaw, of the University of Strathclyde, Glasgow, UK, takes care of sensing systems,
- Friswell, of the University of Swansea, UK, deals with vibration control; Inman, of Virginia Polytechnic Institute, Blacksburg, USA, is his co-author;
- Worden and Starzewski, of the University of Sheffield, develop the concept of Data Fusion,
- Morgan and Friend, of Cranfield University, UK, explain the basic concepts on the back of shape memory alloys,
- King, of the University of Leeds, UK, gives a well-organized summary on piezoelectric material, having Pozzi, of Thammasat University, Thailand, as co-author;
- Jenner and Lord, of the Universities of Hull and Salford, UK, respectively, deal with magnetostriction;
- Bullough, as said, covers the topic of smart fluid machines,
- van Noort, Hattan and Haddow, of the Sheffield group, give an overview on smart biomaterials;
- Vincent, of the University of Bath, UK, contributes a chapter titled: Natural Engineering as the Smart Synergy.

The book has not a Subject Index, Chapter 2 does not list any reference and, in general, the bibliography is rather dated and focused on the production of a limited number of research groups. Nevertheless, *Smart Technologies* differs from similar products one can find in any bookstore, thanks to the rigor guaranteed by the scientific value of the chapter authors. The readability of the book is excellent. It is the result of the care the authors show in presenting the material, but the chapters are also very well written.

The editors' preface underlines how the material is presented in non-mathematical terms. This ensures the accessibility to the book of undergraduate students and hence the volume is mainly though for libraries, but also non-specialist technicians could find convenient to buy it as a reference book.

7R6. Analysis and Optimization of Prismatic and Axisymmetric Shell Structures: Theory, Practice, and Software. - Edited by E Hinton *(Dept of Civil Eng, Univ of Wales Swansea, Singleton Park, Swansea SA2 8PP UK),* J Sienz *(Dept of Mech Eng, Univ of Wales Swansea, Singleton Park, Swansea SA2 8PP UK),* and M Ozakca *(Dept of Civil Eng, Faculty of Eng, Univ of Gaziantep, Gaziantep 77310, Turkey).* Springer-Verlag London Ltd, Surrey UK. 2003. 496 pp. ISBN 1-85233-421-5. $159.00.

Reviewed by CH Yoo (Civil Eng Dept, Auburn Univ, 238 Harbert Eng Center, Auburn AL 36849-5333).

This is a very useful reference book on analysis and optimization of prismatic and axisymmetric shell structures. Optimization presented in this book is based on mini-/maximizing objective functions dealing with structural shapes, weight, buckling strengths, and/or natural frequencies of structures like many other books written on the subject of structural optimization. Optimum structural design in a general sense encompassing many intangible variables including minimum overall cost, maintenance, long term performance (fatigue, corrosion), aesthetics, and owner's satisfaction, is perhaps beyond the realm of mathematical tools.

The book is divided into five parts. Part I: Introduction (Chs 1–3), Part II: Static Analysis and Optimization (Chs 4–6), Part III: Free Vibration Analysis and Optimization (Chs 7–9), Part IV: Dynamic and Buckling Analysis and Optimization (Chs 10–11), and Part V: CD-ROM.

Chapter 1 lays down the foundation of the book including the main objective of the book, review of previous work, limitations and scope of the work, basic definition of terminology, and layout of the book. Chapter 2 deals with structural shape definition and automatic mesh generation. Chapter 3 presents structural optimization methods and algorithms dealing with classification of problems treated, overview of optimization algorithms, and sensitivity analysis.

Chapter 4 verifies the validity of the basic finite element formulation for shells of revolution by comparing the solutions with a few benchmark examples. Chapter 5 presents the basic finite strip formulation for prismatic shells. The analysis is carried out using Mindlin-Reissner finite strips. Using a single cell and multi-cell curved box-girder bridge examples to test the developed method appears to be ill-advised as the procedures and dimensions presented in the book are far from those used in practice. Most concrete box-girders, if not all, are post-tensioned. As a consequence, thicknesses of concrete boxes are frequently determined to accommodate the pre-stressing forces. In the case of steel-concrete composite box-girders, the dimensions of the steel box are frequently determined considering it as a semi- or completely open cross section (tub-girder) under the construction loads. Chapter 6 deals with structural optimization of shells of revolution and prismatic shells. Because of the simple objective functions (weight minimization or strain energy minimization) employed, very interesting (impractical) optimal thickness variations of a cylindrical tank or a square plate emerge.

Chapters 7 and 8 are devoted to the basic finite element formulation for vibrating axisymmetric shells and the finite strip formulation for vibrating prismatic shells, respectively. Mindlin-Reissner theory is used for the analysis. Chapter 9 is concerned with structural shape and thickness optimization of vibrating axisymmetric and prismatic plates and shells. The objective function to be maximized is the fundamental frequency.

Buckling analysis and optimization of prismatic and axisymmetric plate and shell structures are presented in Chapter 10. Chapter 11 considers additional approach to the analysis of axisymmetric and prismatic shells. Included in this chapter are some very interesting comparisons of numerical solutions obtained using the developed computer program and known closed form solutions.

A salient feature of *Analysis and Optimization of Prismatic and Axisymmetric Shell Structures: Theory, Practice, and Software* is the inclusion of the computer program written in Fortran77 along with a free Gnu Fortran compiler g77 and Gnu PostScript interpreter under the Gnu Public License. This is a tremendous contribution to practicing engineers who do not have a ready access to high power computing facilities along with rich software libraries. Although Gnu programs are free, it is not easy for a novice to extract what he needs from the tangle of the website. In all current main programs and subroutines, the authors utilize the PARAMETER statement, thereby achieving semi-dynamic storage allocations. Despite the authors claim, documen-

tation included in the Tools section of the CD-ROM is choppy and brief. Some commands in Tools simply did not work. There are too many abbreviations used in the text. For example, SAM is meant for semi analytical method instead of surface to air missile. Users are forced to read from the beginning to understand SAM. The nature of the book being a reference, this is a bothersome shortcoming.

There are several impractical optimums structural shapes presented in the book. Perhaps introducing constraints, ie, higher order continuity, in the structural shapes, could alleviate these problems. Despite shortcomings, the book is highly recommended for engineering offices and libraries.

V. MECHANICS OF FLUIDS

7R7. Axial-Flow Compressors: A Strategy for Aerodynamic Design and Analysis. - Edited by RH Aungier *(Ebara Group, Adv Tech, Elliott Turbomachinery Co Inc, Jeannette PA).* ASME International, New York. 2003. 361 pp. ISBN 0-7918-0192-6. $95.00.

Reviewed by S Farokhi (Dept of Aerospace Eng, Univ of Kansas, 2004 Learned Hall, Lawrence KS 66045).

The title of the book is rather lengthy, but accurate, in describing the author's goal in providing a foundation for aerodynamic design and performance analysis of axial-flow compressors. Therefore, the book is neither an introduction to the subject nor an academic textbook in a classical sense. Other important aspects of compressor design, namely, structural design and topics such as flutter or noise are entirely (and intentionally) omitted from this book. The author has thus produced successfully a reference book with sufficient detail that treats compressor aerodynamics from the viewpoint of a design and performance engineer. However, within the realm of aerodynamic design, the author does not treat compressor stall and surge phenomena in any great detail. The effects of unsteadiness on performance are left out of this book's treatment of compressor aerodynamics. These omissions however do not detract from the value of this book being a modern reference to compressor aerodynamic design and performance evaluation. This book successfully integrates classical cascade aerodynamics of the 50's with today's computational methods dominating modern compressor design.

The Axial-Flow Compressor book by Aungier has 13 chapters spread over 348 pages. The average chapter length is thus ~27 pages. Most chapters contain a few exercises at the end that are also nearly solved in the *Answer to Exercises* section at the end of the book. The introduction chapter quickly sets the stage for the rest of the book, which is entirely focused on axial-flow compressors. The review of thermodynamics and fluid mechanics in chapters two and three also follow the same principle. The author's industrial turbomachinery background (as well as his personal contributions to the field) has prompted the inclusion of non-ideal gases and multi-phase flow in the thermodynamic review chapter. The treatment of general equation of state (other than the perfect gas law) is a valuable addition to any engineers' toolbox tasked with treating general fluid flow problems. The fluid mechanics review chapter (Chapter 3) quickly evolves into an appropriate set of conservation equations describing compressible flow in turbomachinery including the end wall boundary layer equations. Blade profiles are treated in Chapter 4. The classical compressor profiles developed by NACA (eg, 63- and 65-series) and the British, as well as, double-circular arc blades are presented in detail in Chapter 4. The controlled-diffusion airfoil, as primarily a proprietary and application-specific profile, is only qualitatively presented. Chapter 5 treats 2D blade-to-blade flow through cascades of blades using possible approaches in computational fluid dynamics. These include the potential flow approach, the transonic time-marching approach as well as describing the blade surface boundary layer solution techniques. The author's insight in the application of the computational techniques provides for valuable hints and suggestions for the readers who wish to implement the described methods. Chapter 6 contains numerous correlations of (classical) empirical cascade performance data and their modern extensions. The tip clearance loss, as well as the shroud seal leakage loss, is also presented in Chapter 6. Chapters 7–9 lay the computational foundation of meridional through-flow analysis, end-wall boundary layers and compressor aerodynamic performance analysis, respectively. These chapters are presented with sufficient detail and clarity that an engineer with some computational facility should navigate through them with no problem. Compressor stage aerodynamic design is presented in Chapter 10. Again, author's insight and personal experience, guides the reader through conventional and non-conventional stage (vortex) designs and the range of appropriate non-dimensional parameters in compressor aerodynamics are explored. The principles that are detailed in the first ten chapters are used in designing several multi-stage axial flow compressors in Chapter 11. The impact of non-dimensional design parameters on compressor performance is explored. An extension of earlier computational techniques to quasi-3D inviscid flow analysis is covered in Chapter 12. Again, the viscous effects are treated by a boundary layer approach. Chapter 13 covers the *Other Components and Variations* with topics such as exhaust diffusers, adjustable stators, scroll or collector, Reynolds number and surface roughness effects and a brief discussion of axial-centrifugal compressor. As noted earlier, *Answers to the Exercises* section is nearly the complete solution to the exercises, which make it easy for those who intend on solving the problems. There are 104 references that are all collected at the end of the book. The classical works are cited. The latest work in the reference section is the author's book on centrifugal compressors (2000). Thus later references beyond 2000 and many seminal contributions to the field of compressor aerodynamics are not included in the references. However, the author's objective of providing a detailed strategy for aerodynamic design and analysis is clearly achieved, even with the shortcomings that are cited. *Axial-Flow Compressors: A Strategy for Aerodynamic Design and Analysis* is a valuable resource to engineers, students and academicians who are interested in elements of axial-flow compressor stage and system design.

7R8. Two-Phase Flow: Theory and Applications.-Edited by C Kleinstreuer *(Dept of Mech and Aerosp Eng, N Carolina State Univ).* Taylor & Francis Publ, New York. 2003. 454 pp. ISBN 1-59169-000-5. $125.00.

Reviewed by P Griffith (Dept of Mech Eng, MIT, Rm 7-044, Cambridge MA 02139).

This book is written primarily as a text for an interdepartmental, graduate course in multiphase flow. The level of mathematics assumed in this book is unlikely to be appropriate for undergraduates. Though experimental results are cited whenever it is appropriate, the focus of the book is in describing the analytical models that are available for handling a wide range of two-phase flow problems of interest to a variety of engineers. The experiments are not stressed. Though the examples that are presented in some detail are of primary interest to mechanical, bio-medical, and chemical engineers, the tools that are introduced are also of interest to many nuclear and some environmental engineers. An assumption underlying much of what is presented in the book is the problems will, ultimately, be solved on a computer.

The book starts with a compact review of single phase, incompressible fluid mechanics. It then proceeds to develop in general terms the conservation equations for mass, momentum and energy that form the basis of all the solutions for fluid mechanics problems. At that point the author goes on to present the various models that have been developed to solve these problems. These include the homogeneous model, the drift flux model, the separated flow model, the two-fluid model, flow regime based models and several variations on these

models. This part of the book is particularly useful because of this section. No other text has such a complete a summary of the strengths and weaknesses of the various models. These models are compared on the basis of the kinds of problems they are particularly well adapted to and for, and the nature and amount of empirical information that must be provided in order for the model to be used. Mention is made of the analytical difficulties that might arise when a particular model is adopted and what constitutes an appropriate set of boundary conditions.

An equally useful feature of this book is a listing of a number of canned, general-purpose fluid mechanics codes that can be used to solve the problems that arise in two-phase flows. The comparison is in the form of a chart and lists the kinds of problems that can be solved and the kind of supporting information that must be provided. In order to complete the formulation of the problem. The guidance given in this book on model selection and code selection is unique and very useful.

The later sections in Two-Phase Flow: Theory and Applications are devoted to examples demonstrating the application of these tools to a variety of problems. These examples include the following;

Spray modeling,

Bubble column modeling,

Solids suspension in a turbulent flow,

Blood flow in blood vessels to identify where deposits will build up, and

Solids carried with air into lungs to identify where solids are deposited.

These examples are useful illustrations but are well documented so they can be cited as solutions to these problems.

This book provides an up-to-date survey of the models and analytical methods now available to solve a great variety of two-phase flow problems. The computer programs that are available along with their strengths and weaknesses are listed. It is not a handbook but it does contain an extensive list of references and the details for the problems that are described.

7R9. Breakup of Liquid Sheets and Jets.– Edited by SP Lin *(Dept Mech and Aeronaut Eng, Clarkson Univ).* Cambridge Univ Press, Cambridge, UK. 2003. 269 pp. ISBN 0-521-80694-1. $75.00.

Reviewed by KJ Ruschak (Global Manufacturing Tech Org, Eastman Kodak Co, Kodak Park Bldg 10, Flr 5, Rochester NY 14652-3703).

Breakup of Liquid Sheets and Jets is a monograph on the mathematical analysis of the hydrodynamic stability of laminar sheets and jets. Linear stability, the initial evolution of small disturbances, is the primary focus, and so the word *stability* would be more accurate than *breakup* in the title. Consideration is limited to Newtonian liquids with constant and uniform surface tension. The book is theoretical and mathematical but reviews relevant experimental measurements and observations. A solid background in capillary hydrodynamics, hydrodynamic stability, and applied mathematics, notably analytic surface geometry and complex variables and analysis, are requisites for the reader. A paucity of background material and the typically concise mathematical development at a high level makes the book unsuitable as a textbook or as an introduction to the subject matter.

The book primarily analyzes the Navier-Stokes equation linearized about simple exact solutions, the Orr-Sommerfeld equation or counterpart. Stability is determined from a normal mode or eigenfunction analysis. An *energy budget* computation may follow as an aid to interpreting results and elucidating mechanisms. The importance of considering disturbances that evolve both temporally and spatially is emphasized. The book first treats the problem of a uniform sheet or jet of inviscid liquid moving through an inviscid gas at rest. Complications are then added, such as a gradual variation of sheet or jet thickness due to gravity, and viscous effects. Because the approach is analytical, the inclusion of viscosity requires the sheet or jet to be surrounded by a conduit. Nonlinear stability analysis and computational fluid dynamics are briefly treated. An *epilogue* introduces related phenomena, including the breakup of liquid filaments; drop formation from a nozzle, and excited atomization at a nozzle tip.

The many photographs of flow instabilities are effective at stimulating interest. The book has a detailed table of contents, a four-page author index, and a three-page subject index. The graphics are generally clear and effective, although some plots are busy and definition sketches are sometimes spare or omitted. Some descriptions are confused; for example, the simple vertical sheet thinning by gravity in Figure 4.1 is inexplicably described as being ''extruded vertically downward by the viscous drag exerted by the horizontal moving plate.'' Indeed, the book is careless for one purporting mathematical rigor. As examples, there are mistakes right from the beginning, the first occurring in equation (1.5), and the Heaviside step function is referred to as the ''heavy side'' step function. Although there is a listing of notation, it is not exhaustive, and symbols are not always defined in the text when first used.

The author has produced a detailed review of existing results from analytic approaches to the linear stability of jets and sheets of Newtonian liquids of constant and uniform properties. Breakup is not the focus of the book despite its title. Readers interested in applications will find the material limited. For example, little consideration is given to the excitation of instabilities to promote and control breakup, although this is common in practice. *Breakup of Liquid Sheets and Jets* will be valuable to those conducting research in this specialized area of hydrodynamics and useful as a reference to those possessing the required background and having broader interests in capillary hydrodynamics.