AIAA JOURNAL
Vol. 38, No. 9, September 2000

Book Reviews

Ultrasonic Waves in Solid Media

Joseph L. Rose, Cambridge University Press, New York, 1999, 454 pp., $90.00

Ultrasonic wave techniques are used extensively in nondestructive evaluation and medical diagnosis. In the preface of this book, the author declares that "Engineers, technicians, and students involved in ultrasonic nondestructive evaluation (NDE) will appreciate the usefulness of this textbook." He also hopes that "... this book will be used as a reference in ultrasonic NDE by individuals at any level and as a textbook for seniors and graduate students." The author has succeeded admirably. The book is highly suitable as a textbook for seniors and graduate students, and it is an adequate reference for basic ultrasonic physics in solids. This book consists of 20 chapters and five appendices with a 12-page-long bibliography of earlier classic textbooks and key works. The book is self-contained, including all of the necessary background in theory of elasticity, mathematics, and NDE principles.

The primary focus of the book is modeling and understanding the physics of bulk and guided-wave propagation in isotropic and anisotropic media. Mathematical modeling is emphasized. After an introductory Chapter 1, the book covers a wide range of wave propagation phenomena in solids at a leisurely pace, including many examples. The subjects presented include the concepts of dispersive waves, dispersion relation and group velocity, bulk wave propagation in infinite and semi-infinite media, reflection and refraction, oblique incidence, wave scattering, surface and subsurface waves, waves in plates, interface waves, waves in rods and in hollow cylinders, guided waves in multiple layers, source influence, horizontal shear, waves in anisotropic layers, elastic constant determination, waves in viscoelastic media, and residual stress influence on ultrasonic wave propagation. The last chapter is an introduction to boundary element modeling in ultrasonic wave propagation problems. Although the book covers the basics of waves in anisotropic materials, the majority of the examples show the development in the isotropic case.

One of the outstanding features of this book is that at the beginning of each chapter the author clearly describes the mathematical model or models of the problem of interest. He then gives the analytic solution, supported often by numerical results. The examples in each chapter are carefully selected. The physics of the problem is then elaborated with reference to practical ultrasonic tests. One learns about all major types of waves in solids, such as Rayleigh, Lamb, Love, Stonely, and Scholte waves. Wherever appropriate, the author inserts a summary of the significant results of the section. Careful attention is paid everywhere to give the related references in the bibliography at the end of book. The book does not require knowledge of advanced mathematics beyond a good background in undergraduate mathematics, such as calculus, basic ordinary and partial differential equations, and complex analysis. In addition to an appendix on complex variables, sometimes a section on mathematics is introduced within a chapter, e.g., in Chapter 15, to help the readers to follow the procedure of obtaining analytic results. There are exercises for classroom use at the end of all chapters except Chapter 1 and in three appendices.

There are five appendices that together are about 100 pages long. Appendix A, entitled "Ultrasonic Nondestructive Testing Principles, Analysis and Display Technology," includes the physical principles behind NDE, wave interference, a computational model of a single-point source, the directivity function for a cylindrical element, ultrasonic field presentations, near-field and angle of divergence calculations, beam control, field solution techniques, pulsed ultrasonic field effects, display technology, and some other practical subjects. Appendix B, called "Basic Formulas and Concepts in the Theory of Elasticity," presents the fundamental results of elasticity theory used in the book. Appendix C, called "Complex Variables," gives the basic results of the subject, including the residue theorem. Appendix D, "Schlieren Imaging and Dynamic Photoelasticity," considers some of the techniques of visualizing ultrasonic wave propagation but is only three pages long. Appendix E is called "Key Wave Propagation Experiments" and is about 40 pages long, and here the author discusses seven key experiments. For every experiment, the author describes the goal, the procedure, and the expected results. Sample outcomes of the tests are included in the appendix. These experiments are suitable for a course in ultrasonics supported by laboratory work. Although the generic test equipment needed for each experiment is mentioned in the book, the author has avoided specifying the manufacturer of each apparatus. This will cause an added burden for those who would want to set up a laboratory to complement classroom usage of the book.

The author's writing style is very clear and readable, and there are many line drawings typical of what is found in the literature of NDE. The index is fewer than four pages long and too short for a book of this size. Perhaps a separate author index would be preferable because of the fairly large bibliography. As with most books containing many equations and figures, inevitably some misprints and errors appear. For example, there are several sign errors in equations on page 27. In Fig. 4.10, the critical angle shown is in error. Figure 8.1 gives the wrong impression to the reader that the wavelength of the Rayleigh wave decreases below the surface. These are only minor errors. The author has written an excellent book for all who want to learn about ultrasonic wave propagation and NDE. It is highly recommended as a textbook for senior-level and graduate students. It would provide a good starting point for students interested in many of the mainstream ideas of NDE that have been explored in the past 10 years. Engineers and researchers in NDE and ultrasonics will also find this book useful in their work as a basic reference.

F. Farassat
Eric Madaras
NASA Langley Research Center

Advanced Transport Phenomena

John C. Slattery, Cambridge University Press, New York, 1999, 709 pp., $54.95

This book is one of the Cambridge Series in Chemical Engineering and is intended for first-year graduate students, though the author says that it should also be useful to research workers. Naturally, the discussion includes some matters of interest only to chemical engineers, such as the flow of non-Newtonian fluids. However, equally naturally, the treatment of the basics of transport of momentum, energy, and mass (in that order) is much what one would find in a textbook for mechanical or aeronautical engineers. I do not think educators in the latter fields would want to use Prof. Slattery's book as a primary text, but it would be beneficial to students to see the similarities and differences between the treatments of transport phenomena in their fields and in chemical engineering.

The book has 10 chapters and two appendices. After an introductory chapter called "Kinematics," which introduces the all-important transport theorem, each of the three transport phenomena is treated by chapters on "Foundations," "Differential Balances," and "Integral Balances." The approach is very thorough and somewhat formal, though less so than an analogous book written by an applied mathematician would be. Professor Slattery lists a subset for an 84-hour (two-semester) course, which is somewhat more than half the material in the book and includes most of the 65-page appendix on tensor analysis: the latter would be quite a respectable text on its own. Evidently the Chemical Engineering Department at Texas A&M University believes in students learning mathematics "on the job" rather than in dedicated courses.

The author stoutly defends his traditional approach of deriving analytic, sometimes approximate, solutions for idealized problems rather than producing numerical solutions for more realistic problems. However, he does encourage students to use programs such as Mathematica to produce analytical or numerical solutions for the more difficult exercises. It is certainly true that running software written by somebody else is not a good way of understanding the basics of any subject. However, these days the ability to run, and assess the accuracy of, computer codes is a large part of the duties of most engineers, and M.S. students, if not B.S. students, ought to acquire that ability before graduating.

Chemical engineers in the aerospace industry would find this book useful in getting up to speed on fluid flow; aerodynamicists, like students, would find it educative to see how other disciplines teach their subject.

Peter Bradshaw
Stanford University