journal of applied mechanics

book reviews

Finite Element Analysis in Fluid Dynamics. By T. J. Chung. McGraw-Hill Book Company, New York. 1978. Pages xiii-378. Price $38.

REVIEWED BY G. F. CAREY[1]

This book has, in essence, been written in two parts. The first half is a short treatment of finite element methods akin to that presently available in several texts. This material might equally well be utilized in conjunction with other fields of finite element application such as solid mechanics or stand alone as an introductory treatment of finite elements. With the exception of a brief excursion into the Ciarlet-Raviart interpolation theory in the latter part of Chapter 3, this first part provides an elementary presentation of the main features of the method itself. The reader unfamiliar with finite elements should find it adequate preparation for applying finite elements to many flow problems.

In the latter half, the exposition begins with a concise development of fundamental equations in fluid mechanics and subsequent chapters treat specific classes of flow problems such as incompressible and compressible flows. The treatment of fluids and finite elements here is too brief if one considers the diverse nature of flow phenomena and the variety of related problems in finite element theory and technique that yet remain unresolved. As far as the basic methodology and applications are concerned—and these are the main foci of the text—there is a considerable collection of material here of general interest in flow computation. A substantial proportion of this part is conveyed via applications drawn from journal literature. Consequently, the style departs from that of the earlier chapters on finite elements. This does not generally detract from the quality of the presentation although in some instances, such as the analysis of compressible flow in Chapter 6, the discussion occasionally resembles a review rather than a pedagogical development of the subject.

The strengths of the text lie in the discussion of basic methodology. There is some attention to mathematical analysis but this is not comprehensive nor is it representative of the general scope of this volume. Questions of accuracy and analysis of the method are largely confined to the latter part of Chapter 3. There a brief nonrigorous discussion of interpolation theory is followed by a more extensive summary of the Ciarlet-Raviart theory for finite element interpolation and estimates.

The technical aspects of the book are generally quite sound although there are a few minor oversights. (For instance: claiming that all elements are of Lagrange and Hermite type (p. 59), whereas singular elements and rational elements among others are also used; confusing the differencing concepts in equations (3)–(54a–c) for a parabolic problem; incorrectly stating that mesh refinement leads to oscillations for convection-diffusion problems (p. 310), whereas this difficulty is actually associated with coarse meshes.)

The presentation is lucid but the style is occasionally formal and stilted. One wonders if an integrated development of the two topics from the outset might be a preferable format. Also, a less extensive discussion of very introductory finite element concepts in the first part would have permitted elaboration of more complex issues that are not present now. (These might include nonconforming methods for Stokes flow, multipliers and penalties for handling incompressibility constraints and the consequent numerical difficulties, analysis of stability and oscillations for vorticity transport or convection-diffusion, to cite a few representative topics.) More analysis, in the style of the fine treatise by R. Temam on Navier-Stokes equations would also be appropriate and would have been more suggestive of an "Advanced Book Program." However, as a basic and broad treatment of finite elements with applications to fluids, the text is a useful resource.

The Physics of Vibration. Vol. 1, containing Part 1, **The Simple Classical Vibrator.** By A. B. Pippard. Cambridge University Press, Cambridge, England. 1978. Pages ix + 431. Price $54.

REVIEWED BY S. H. CRANDALL[2]

This is an unusually stimulating technical book. It is not a textbook in the usual sense. The author states that its purpose is to "bridge the gap between the normal undergraduate curriculum and detailed treatments of special topics at the research level." This reviewer found it to be a delightful collection of penetrating physical insights into a wide range of vibratory phenomena from the simple pendulum to nuclear magnetic resonance. Put off to a future second volume are two more parts addressed to quantum vibrations and to complex vibratory systems.

The exposition is principally by means of individual examples, loosely organized into chapters. Simple experiments and qualitative explanations abound. Graphical representations are preferred to formal mathematics. When mathematics cannot be avoided it is generally as simple as possible. The range of material covered under the heading "the simple classical vibrator" is extremely broad. An early chapter on Fourier series and integrals includes noise and random processes. The chapter on waves and resonators includes discussions of the fingerholes in woodwind instruments and of the phenomenon of anomalous dispersion. The chapter on velocity-dependent forces includes the effect of rotating damping on the stability of whirling rotors, the gyro pendulum, and cyclotron resonance. There are many excellent qualitative explanations in the chapters on nonlinear vibrations and on parametric excitation. The chapter on coupled vibrators treats damped systems (as well as undamped systems) and frequency entrainment of nonlinear oscillators.

There is a fairly elaborate system of cross-referencing of topics within the book. This facilitates taking the author's advice to "skip the boring bits." One can pick up the book at any point of interest and be directed back to earlier passages when they are relevant. The presentation is everywhere lucid but concise. This reviewer had to go slowly, even in material he has familiar with, but the journey was always worth the trip. Every teacher of a course in vibration should have this book, next to his or her copy of Den Hartog.

---

[1] Professor, Department of Aerospace Engineering and Engineering Mechanics, The University of Texas at Austin, Austin, Texas 78712.

[2] Ford Professor of Engineering, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. 02139.