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REVIEWS

Sound and Sources of Sound. By A. P. Dowling and J. E. Ffowcs Williams. Ellis Horwood, 1983. 321 pp. £25 hardback, £8.50 paper.

Recognizing the lack of suitable engineering undergraduate texts in this field, I accepted a request to review this book with interest and enthusiasm. I noted that, in their preface, the authors explain that they had based their book on undergraduate engineering courses in Cambridge. Here also they draw attention to a strong topical engineering interest in sources of sound, which they set out to satisfy. They candidly point out, however, that the illustrative material presented has been restricted to those topics they find interesting, most enjoyed studying and found most useful.

The book has been divided into eleven chapters of varying length, with a useful set of exercises at the end of each one. The book concludes with some fifty pages of worked solutions to the exercises, followed by ten pages of useful data and definitions. There is no bibliography, nor any specific references to sources excepting three figures reproduced from *NACA Report* 1152.

The first five chapters (112 pp.) are concerned with sound and its propagation, and the sixth (21 pp.) with resonators and diffuse sound fields. The level of the approach adopted here is, in general, elementary. Chapter 5 (25 pp.), however, which concentrates on ray acoustics and sound propagation in the sea and the atmosphere, contains some quite demanding mathematical analysis in §5.2. Chapters 7–9 (62 pp.) are concerned, broadly speaking, with sound sources, including sound scattering and moving sources. The level of the approach here is in direct contrast to the preceding parts of the book and remains quite mathematically demanding for the remainder of the book. Chapter 10 (26 pp.) presents a concise and useful account of signal processing, while chapter 11 (24 pp.) is concerned with flow-induced vibration and instability.

The general approach throughout the book is mathematical, which is competently presented in some detail, with many illustrations of useful analytical techniques. With this emphasis, in what is not a long book, the presentation of the underlying physical basis on which the subject depends is often brief and in places inadequate. This often occurs when a careful appraisal of physical considerations is essential for an adequate grasp of practical constraints in application.

The authors claim that the book is based on an engineering undergraduate course and is intended as an engineering undergraduate text. However, the lack of balance in the topics selected, the disparity in academic standard between its different parts and the concentration on techniques of analysis in preference to physical fundamentals, arouse serious misgivings in my mind as to its acceptability in this role. The inclusion of a large number of exercises and their worked solutions does, however, provide useful material for the student.

One gets the impression that the book has been written in haste and there is certainly evidence of careless proof reading. Mistakes are frequent, involving text, equations and figures, with a few inconsistencies of notation. At best, such carelessness is irritating for the experienced reader. It is more serious in a student text, since such slips undermine the reader's confidence, particularly when they occur as frequently as they do in this book.

The carelessness extends to the discussion, to some definitions and to some of the illustrative examples in the text. On the second page of the first chapter, for example, one finds confusion between power and energy (p. 12), in the description on page 13 of acoustic particle velocity as 'very slow', which is meaningless, and the explanation of the meaning of spectral level on page 32. Similar instances occur frequently throughout the text. At a somewhat less obvious level there are further inconsistencies and obvious errors. For example, in figure 11.2, surely the variable x should be defined as $x^2 = \omega^2/(k^2+\beta^2)$ (see equation (11.8)), not $x = k\omega^2/(k^2+\beta^2)$ as presented. Similarly z should be defined as the square root of $\beta^2/(k^2+\beta^2)$, not as shown. Incidentally, the student might be warned that figure 11.2 presents the squared response, while the subsequent discussion on the meaning of Q (quality factor) is in terms of the response, not its square. The whole example of the simple 'fundamental' forced harmonic oscillator on pp. 236 ff. seems ill-conceived, with many misleading aspects. Why, for example, are partial derivatives used in the single-degree-of-freedom system equation (11.1), and how can this model a beam as shown in figure 11.1?

Secondly, the text can often be faulted for loose or misleading statements and errors of fact. The first chapter seems particularly bad in this respect. Surely, while equipartition of energy between potential and kinetic forms (p. 23) is a characteristic of acoustic plane waves, it is certainly not so for many other vibration processes, although it may be so in the mean. Similarly (p. 55, equation (2.52)), the speed of waves of wavelength λ on water of depth h is given by

$$c^2 = \frac{g\lambda}{2\pi}\tanh\frac{2\pi h}{\lambda}.$$

It is certainly not $c^2 = gh$, when h and λ are approximately equal as stated, but only when $2\pi h/\lambda \ll 1$. Thus also in that some paragraph, the wave speed should be 'wavelength-dependent' rather than their looser 'frequency-dependent'. One finds (p. 83) the statement that sound waves cannot travel parallel to a flat plane surface without suffering severe attenuation! This arises from taking a purely mathematical expression (4.12) to the limit $\theta = \frac{1}{2}\pi$. In practice, however, this limit, and indeed equation (4.12), should not be strictly applied to 'near grazing' waves on any real surface, because the wave ceases to be plane, so their bare statement is misleading. One might recall here F. G. Friedlander's clear discussion of grazing wave anomalies. Later (p. 90) the authors discuss evanescent waves when surely evanescent modes are implied by the discussion. On p. 92, in addition, surely pressure and velocity are in quadrature, not 'out of phase'. A more subtle inconsistency appears in figure 10.8, where the individual curves of $p(\Delta, t)$ have slopes which rise more slowly relative to their steeper fall, with increasing τ or Δ. These represent non-minimum phase functions, and are the direct reverse of the experimental observations. Thus, as presented they suggest that longer wave components or larger-scale eddies decay faster than smaller ones, a situation different to that normally encountered and representing an unusual physical phenomenon.

Thirdly, though warned in the preface that the authors pursue their own special interests, I find some disquieting omissions in the material presented. Are all ducts invariably provided with anechoic terminations (chapter 3), or can boundary effects at discontinuities be ignored (chapters 3 and 6) without introducing serious deficiencies in predictive analysis? There is, however, a brief discussion in §6.4 (p. 134) on end corrections. Such omissions may not be vitally important in a mathematical text, perhaps, but are a serious deficiency in an engineering one.

When viewed in a somewhat different light, I found much of interest, particularly in parts of chapter 4 and chapters 7–9, with many novel and useful examples of analytic techniques throughout the text. To the more experienced and discriminating reader the book provides both new material and some provocative or challenging concepts. The set of exercises, averaging around six per chapter, with their worked solutions seem both comprehensive and useful. My general feelings are, however, of disappointment that the authors have fallen so far short of the laudable aims expressed in the preface.

P. O. A. L. Davies

Theory of Viscoelasticity: An Introduction, 2nd Edn. By R. M. Christensen. Academic, 1982. 364 pp. $45.00.

The second edition of this book is essentially the first edition of 1971 with additions based on developments since that date. The first three chapters of the first edition form the same chapters of the second edition, and chapters 4, 5 and 6 now become chapters 6, 7 and 8. Because this reviewer reviewed the first edition of *JFM* **55** (1971), 188, the present review will be concerned with the new material of which a full list is given by the author in his preface.

The new chapter 4 consists of a greatly extended account (previously chapter 7) of the numerical determination, from experimental measurements, of the mechanical properties of viscoelastic materials, e.g. complex modulus. This account includes the interpretation both of the transient in wave propagation and of temperature-dependent effects. Lastly the approximate inversion of the Laplace transform is treated.

Chapter 5 considers problems to which the correspondence principle does not directly apply. These are of three main types: contact problems, cracks (in both of which the type of boundary condition at a given point may change with time) and thermoviscoelastic problems. Methods of solution include extended correspondence principles, energy balance and numerical techniques.

In chapter 9, on nonlinear mechanical behaviour, the author considers special forms of nonlinear constitutive relations applicable to particular materials and/or particular situations. Section 1 develops the viscoelastic counterpart of the kinetic theory of rubber elasticity and uses it to solve the creep inversion problem (deduction of the creep function from the nonlinear creep test). Later sections treat acceleration waves, viscometric and nonviscometric flows and viscoelastic lubrication. The chapter ends with a discussion of the present state of nonlinear viscoelastic theory.

In the first of two sections added to chapter 3, the author gives his own derivation of the glass transition criterion using irreversible thermodynamics and the Gibbs function. The second section derives an alternative form of the heat conduction equation.

Anyone coming back to viscoelasticity after a period of years cannot fail to notice the widening scope of the theory. This is well conveyed by chapter 9 of this book. As in the previous edition, many references are given at the end of each chapter. The book will continue to be a useful guide and source of reference for the teacher and for the graduate student.

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