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BOOK REVIEWS

FLOATING, FLOWING FLYING 1998, D. Dijkstra, B. J. Geurts, J. C. M. Kuerten and H. K. Kuiken (editors) Dordrecht: Kluwer Academic Publishers, 253 pp. Price: NLG 195.00; USD 105.00; GBP 67.00. ISBN 0792351282.

This book presents a reprint of the Journal of Engineering Mathematics issue in honor of the 65th birthday of Pieter J. Zandbergen, Professor of Applied Analysis and Mathematical Physics at the University of Twente and President of the Royal Netherlands Academy of Arts and Sciences. The papers included contain a wonderfully eclectic collection of analytical and numerical treatments of various problems reflecting the stimulation of Professor Zandbergen's "Life as Innovator, Inspirator and Instigator in Numerical Fluid Dynamics". A number of photographs from Professor Zandbergen's career are also reproduced.

Of particular interest to the readers of the *Journal of Sound and Vibration* are four papers: The first, by L. Van Wijngaarden, deals with sound radiation by a turbulent bubbly flow in the case of very dilute mixtures as appropriate to the upper ocean levels. In this case, the emitted sound intensity is found to be proportional to the bubble concentration, rather than its square as found by Crighton and Ffowcs Williams in the more dense case. Limited data is presented to substantiate this conclusion. The second paper, by B. Muller, employs a two-time scale, single space scale low Mach number asymptotic analysis to show that the dominant of source of sound in low Mach number flows is the acoustic time change of the heat-release rate. This, of course, is the thermo-acoustic driver in combustion processes and in such phenomena as the Rijke tube. The third paper is a study of boundary integral equation methods for screen problems in aeroacoustics and electromagnetics by H. Schippers. Screens are defined as open surfaces in three dimensional space. The methods are applied to the structural/acoustic analysis of solar arrays of satellites during the launch phase and to radar cross-section predictions for engine inlets of fighter aircraft. The final paper, by R.W.C.P. Verstappen and A.E.P. Veldman, deals with a "spectro-consistent" discretization of the Navier–Stokes equations as a challenge to the Reynolds-averaged (RANS) and large eddy simulation (LES) approaches. Although applied to the incompressible Navier–Stokes equations, this approach is nevertheless of interest to acousticians as LES and RANS are often utilized to provide the acoustic forcing function for low Mach number, viscous computational aeroacoustics (CAA) approaches such as the acoustic/viscous splitting technique.

The remainder of the contributions in this volume deal with such diverse topics as flow during etching processes, Navier–Stokes calculations on boundary-fitted structured grids and in complex-shaped moving domains such as that

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around a lobe pump, rheological properties prediction of flexible polymer molecule solutions, inviscid instability calculations, fully-developed curved pipe flow, numerical calculation of rapidly oscillating solutions, and water waves. The book is a true *tour de force* and a fitting tribute to the widespread interests of Professor Zandbergen.

J. C. HARDIN

DAMPING OF VIBRATIONS, 1998 (editor Z. Osinski). Rotterdam, Netherlands: A. A. Balkema. 562 pp. Price HFL 195; USD 100.00; GBP 65.00.

This book represents a collective monograph of a group of Polish scientists reflecting mainly their contribution to the problem. The separate chapters, written by different authors, are joined by a common editorship. For the convenience of the reader, some introductory chapters are added, and the authors follow a common system of nomenclature.

The choice of topics reflects mainly the scientific results of the authors, but covers a wide diversity of vibration damping problems and contains many essential aspects of the issue. The book includes the main damping mechanisms in mechanical structures manifested through the dissipation of energy. These are both internal friction in materials and structural friction on the surfaces of different connections of machine parts and joints.

The basic concept uses the phenomenological ideas of uniaxial deformation of materials and structures with proper approximation of resulting hysteresis loops. Such limitation of the problem does not permit the investigation of spatial distribution of vibration in damped solid bodies and bring strict limitations on the character of vibration. The last one has to be close to the ambient mono-harmonic vibration.

In the framework of these limitation the authors investigated a wide range of mechanical systems and processes. They include the inner damping in metals and composites, structural friction under tensile, torsion and bending deformations, structural friction in multilayer systems etc. The analysis covers the main forms of vibration excitations: forced, parametric, autoparametric and self-excitation. The results are developed to the final relationship or representative graphs permitting clear mechanical interpretation. This gives the opportunity to use the results in many practical applications. For obtaining the results, the authors apply different analytical approximations utilizing a variety of analytical methods of non-linear mechanics. The application of simulations is limited and does not exploit its modern opportunities.

The authors investigated many engineering systems such as multi-disc clutches, shock absorbers, shafts and rotors with slide bearings, etc. The analysis of these systems was developed to some practical results and recommendations. There is an attempt to indicate the way to optimization of damping in machine structures but this is limited by a short general presentation.

The book is supplemented with chapters devoted to active vibration damping of some special structures and to attenuation of noise. The first one is narrowly concentrated on the selected topics of application of active control for suppression of parametric instability. The problem is formulated in a general

manner with the use of a model of an ideal active system and presents the initial reflection of the entire problem.

The last chapter on the attenuation of noise in mechanical systems gives a short introduction into the problem and contains practical considerations on the attenuation of noise in gear systems and heavy machines with useful practical considerations.

The book as a whole gives an impression of an essential contribution of the authors to the problem described. Some discrepancies in the performance of different chapters are typical features of a collective monograph. In some place the presentation has unnecessary "academic" character with vague final results. Not all models are well substantiated and developed to practical use.

Nevertheless, the book contains interesting and original material on an important area of vibration. The authors and editor perform a large work on completeness and unification of performance. Research and development specialists will find in the book much useful information on the subject. Some problems described can attract the attention of postgraduate students. The book is a helpful supplement to the available literature on vibration damping.

V. I. BABITSKY

MATHIEU FUNCTIONS: FORMULAS, GENERATION, USE 1997 F. P. Mechel, Stuttgart: S. Hirzel Verlag. 236 pp. Hardback, Price: DM 148.00. ISBN 3-7776-0810-6.

The origins of this book are—as pointed out by Professor Mechel in his Preface—almost the same as those of the well-known text by McLachlan (N. W. McLachlan 1947 *Theory and Application of Mathieu Functions*. Oxford: Clarendon Press), with which comparison is inevitable. Both authors have written their books for the practitioner, not for the mathematician. McLachlan, in his preliminary apologia, asserts that his book "... has been written for the technologist, and *is not addressed in any sense to the pure mathematician*, for whom I am not qualified to write. Between the outlook of the two parties lies a gulf as wide as that between sinner and saint or vice versa!". Mechel, similarly, states, "... this book ... was written under the aspects of a user of Mathieu functions for whom these functions are just a tool; it is not at all claimed that the book is a contribution to the development of the mathematical science about Mathieu functions."

But these two books are quite different in style and in the details of their content. McLachlan's is a much more readable text, with about 25 percent given over to a wide variety of examples of the application of Mathieu functions (including some in vibration and acoustics), presented in a reasonably entertaining way. Mechel's book—which is just over half the length of McLachlan's—is much more terse in style, with relatively little verbal text, and lacks an index. Although it is eruditely written by an author with considerable experience in the subject, it is less didactical and is more in the way of a "... formula collection" (as Mechel states in his Preface). There is, however, one chapter devoted to an "outer problem" in acoustics: the scattering of a plane or cylindrical incident wave by a "dam" (i.e., barrier) of semi-elliptical cross-section, situated on a rigid or yielding plane surface. McLachlan, in contrast,

considers both "inner" and outer problems in his examples (with perhaps greater emphasis on the former). The chapters in Mechel's text are agreeably short from the reader's point of view (though numerous: twenty-two in all, excluding the Preface and Appendix) and this feature helps in the use of the book, compensating partially for the lack of an index as one leafs to and fro in an effort to find particular items with the aid of the Table of Contents.

Mechel's book was published fifty years later than McLachlan's and is very much up-to-date in that it contains listings of a series of computer subroutines (in *Mathematica*) for the computation of azimuthal and radial Mathieu functions and associated quantities. These routines are also contained in digital form on a 1·4 MB diskette (in Macintosh format) that is supplied with the book. There are plentiful two- and three-dimensional plots of Mathieu functions in the book, in addition to tabulated values of characteristic values and Fourier coefficients of $ce_m(x, q)$ and $se_m(x, q)$, and values of these functions themselves. It is a pity that the choice of the Macintosh format severely restricts the ready use of the diskette by the readership at large.

Notation is perhaps the worst of the several problems that beset Mathieu functions, being considerably more complicated than that of other higher functions. Mechel essentially adopts the notation of Meixner and Schäfke (J. Meixner and F. W. Schäfke 1954 *Mathieusche Funktionen und Sphäroidfunktionen*. Heidelberg: Springer Verlag), with a few changes in terminology. At the very outset of the book—in Chapter 1—the notation is discussed, before the elliptic cylindrical co-ordinate system and the governing differential equations are introduced. This certainly does not enhance an understanding of the content of the book by the reader who is not familiar with Mathieu functions, and one feels that a more gradual introduction to the topic would have been more appropriate. Mechel's description of the notation is concise and clear enough, given some prior understanding of Mathieu functions.

Chapter-by-chapter, the contents of Mechel's book are briefly as follows.

Chapter 1 describes the notation conventions and the general analytical and numerical scheme for the generation of Mathieu functions. Chapters 2 and 3 describe (respectively) the elliptic cylindrical co-ordinate system and the governing differential equations and general properties of solutions. So-called "Floquet solutions" (involving a characteristic exponent) are described in Chapter 4.

Chapters 5–9 cover the various types of Mathieu functions, with definitions, properties, Fourier coefficients, asymptotic expressions *et cetera*. Even and odd azimuthal Mathieu functions are described in Chapter 5, radial Mathieu functions in Chapter 6, Mathieu functions of the second kind in Chapter 7, radial Mathieu functions with an asymptotic behaviour like that of cylinder functions (satisfying Sommerfeld's radiation condition) in Chapter 8 and Bessel type Mathieu functions of integer order in Chapter 9.

Special values of certain Mathieu functions are given in Chapter 10, a short list of relationships between Mathieu functions in Chapter 11, integrals involving Mathieu functions in Chapter 12 and representations of Mathieu functions by integrals in Chapter 13. Representations of various other functions, and

obliquely travelling simple harmonic plane waves, in terms of Mathieu functions are given in Chapter 14.

Chapter 15 lists symmetry and orthogonality relationships, and Chapters 16–18 are devoted to the first three steps in the computation of Mathieu functions of integer order, respectively: formulation of the characteristic equation for azimuthal Mathieu functions, determination of the characteristic values, and computation of Fourier coefficients.

Chapter 19 covers the aforementioned application of Mathieu functions to an outer problem, Chapter 20 contains tables of numerical values, Chapter 21 gives both 2D and 3D plots of Mathieu functions and Chapter 22 has listings of *Mathematica* programs. The Appendix contains useful pieces of information relating to recursive methods in computation, e.g., Muller's and Newton's methods (the latter for a bi-diagonal homogeneous system of equations), Bessel functions and continued fractions.

The quality of the English is good overall, though there are what appear to be occasional lapses in proof-reading (e.g., "save" instead of "safe" on p. 1 and "wit" instead of "with" on p. 20). These do not constitute a significant irritation.

This is definitely not a book for bedtime reading, but it will prove a very useful complement to the textbook by McLachlan. It is recommended to those who are engaged in the computation of Mathieu functions, containing as it does much invaluable additional information, laid out systematically with a consistent notation. Both books would be required by the uninitiated, and should be read in chronological order.

A. CUMMINGS

ACOUSTICS OF LAYERED MEDIA I: PLANE AND QUASI-PLANE WAVES (second, updated printing) 1998 L. M. Brekhovskikh and O. A. Godin. Berlin: Springer-Verlag. x + 242 pp, Price DM 98.00; öS 716, sFr 89.50, FF 370, GBP 37.50, USD 59.95. (paperback). ISBN 3-540-64724-4.

The roots of this monograph go back to the classic book by L. M. Brekhovskikh, *Waves in Layered Media* (New York: Academic Press, 1960), which presented "a systematic exposition of acoustic and electromagnetic waves in layered media". In contrast to the classic book the focus of the monograph is a systematic presentation of the theory of plane and quasi-plane wave sound propagation in fluid and elastic layered structures which can be either man-made (e.g., ultrasonic filters, lenses, surface-delay lines) or natural media (e.g., the ocean or atmosphere). A sequel to the present monograph by the same authors [*Acoustics of Layered Media* II—*Point Sources and Bounded Beams* (Berlin: Springer-Verlag, 1992)] builds upon and extends the exposition to address acoustic fields associated with localized sources in moving media and range dependent environments.

The present monograph consists of ten chapters titled as follows: 1. Basic equations for wave processes in fluids and solids, 2. Plane waves in discretely layered fluids, 3. Monochromatic plane-wave reflection from continuously layered media, 4. Plane-wave reflection from boundaries of solids, 5. Reflection of sound pulses, 6. Universal properties of the plane-wave reflection and

transmission coefficients, 7. Acoustic waves in absorbing anisotropic media, 8. Geometrical acoustics. WKB approximation, 9. The sound field in the case of turning horizons and resonant interaction with a flow and 10. Sound reflection from a medium with arbitrarily varying parameters.

Several of the topics which were previously addressed in *Waves in Layered Media* are again covered in the present monograph in more depth and from a new point of view. A partial list of such topics includes: energy and power considerations, transient reflection and transmission problems, and various exact and asymptotic solutions for continuously stratified fluid half-spaces. Additional material which was not contained in *Waves in Layered Media* is also introduced in the present monograph, e.g., a development of the wave and related equations for liquids and solids, the acoustics of moving media, absorption and waves in anisotropic media and inhomogeneous media. Over 400 references are provided in the monograph with the latest being published in 1997.

Although the authors note the material has been used in undergraduate courses on wave propagation in inhomogeneous media and ocean acoustics, no exercises are provided and the emphasis on the mathematics of waves in layered media would, in the opinion of this reviewer, preclude all but the most serious undergraduates. In order to obtain maximal benefit, it is essential that the reader have a strong grasp of applied mathematics including the following topics: ordinary differential equations, special functions, complex variables and asymptotic methods. The level of material is thus considered to be more appropriate for either graduate students or researchers within the engineering, mathematics and physics communities.

In summary, the monograph provides the reader with an excellent overview of acoustic plane and quasi-plane wave propagation in layered fluid and elastic media and the foundation to address more general waveguide propagation problems, e.g., the acoustic field of a localized source in the ocean. However, if the focus of interest of the reader is on the latter waveguide problem the reader would be well advised to also utilize the sequel to the present monograph noted above. The resultant combination of monographs provides a systematic development of acoustic propagation from first principles which should be of interest to researchers in the atmospheric, ocean and seismic communities as well as those that deal with acoustic propagation in man-made layered media.

P. R. STEPANISHEN