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BOOK REVIEWS

Classical and quantum harmonic oscillators, 1997, by S. C. Bloch. New York: John Wiley. *xvii* + 363 pp. Price, hard cover, $71.50; £50. ISBN 0-471-14744-3.

The book consists of twelve chapters, two appendices, and an extensive bibliography listing books, software, and journal articles related to various aspects of oscillatory behavior in dynamic systems. The author states in the preface the purpose of the book (p. xvi): "This book is an elementary introduction to harmonic oscillators with practically no steps omitted." Such a book is important because (p. xv) "The simple harmonic oscillator is a fundamental building block in our system of knowledge of the physical world."

The first four chapters provide a detailed analysis of the harmonic oscillator (HO), including undamped, damped, and forced motions. A large number of concepts are introduced; these range from the equipartition of energy to the delta function. However, few, if any mathematical details or background information are presented to make these concepts comprehensible to the novice. Moreover, certain concepts are stated only for the special case of the HO without an indication that they can be easily generalized and extended to other dynamic systems. The brief discussion in section 2.7 on the equipartition of energy illustrates this point.

Chapters 5–7 introduce and apply the mathematical tools needed for analyzing linear oscillatory systems. A variety of topics are discussed: the classical uncertainty principle, Fourier analysis, Laplace and Hilbert transforms, the convolution and Wiener–Khintchine theorems, and the central limit theorem. Again, little mathematical background is given for these concepts. In a similar vein, Chapter 8 presents all of advanced classical dynamics in less than fourteen pages! Coupled oscillators are examined in Chapter 9 along with several interesting applications involving synchronization, while Chapter 10 surveys statistical concepts in preparation for the introduction of quantum physics in Chapter 11. Finally, in Chapter 12, the author gives a summary of the more important properties of the quantum HO with brief discussions of dynamic variables and their associated quantum operators, electric dipole radiation, and how the quantum wavefunctions should be interpreted.

A diskette comes with the book and contains worksheets that can be run on the Microsoft Excel spreadsheet. Appendix 1 gives instructions for installing the various files and material on the different spreadsheet functions. Appendix 2 presents a quick review of the Hilbert transform and reference to books and journal articles on its derivation and application. Perhaps the best part of the book is the large bibliography—26 pages! For a reader new to most of the topics in the book the numerous listed articles provide the background needed for a full understanding of the contents of the book. In addition, essentially all of the articles are published in the *American Journal of Physics*, a standard periodical in all public and university libraries.

Taken in its entirety, one concludes that this is a very curious book. Its text introduces a variety of topics from almost every field of physics and engineering; particular examples include the Aharonov–Bohm effect, the bang bang, inertial co-ordinate systems, the Planck length, superstrings, and zero-point energy.

The reviewer found the book was fun to read; however, the text does not provide the "hard" science and mathematics needed to actually analyze oscillatory systems. Since the

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book contains no problems, it is difficult to see how it could be used as a textbook. Throughout, the author makes amusing, but quirky asides. These remarks and the facts that they contain are interesting, but often deflect from the particular topic being discussed.

I would recommend this book to all concerned with the general interconnection of the various areas of science. The book clearly shows that the concept of the harmonic oscillator plays an important role in the modelling of a wide ranging set of phenomena in the physical universe. However, for those who want a more detailed, complete, and fundamental understanding of oscillatory systems, this book will be a disappointment.

R. E. MICKENS

An Introduction to the Physiology of Hearing (*second edition*, *fifth printing*), 1997, by James O. Pickles. London: Academic Press, 367 pp. Price (paper back) £24.95. ISBN: 0-12-554754-4.

The first edition of this book was published in 1982, and represented a huge achievement by the author, bringing together a vast array of information from disparate sources. It is written for advanced undergraduate and postgraduate students in the special senses and is a comprehensive account. The second edition was first published in 1988, and this reviewer's copy was provided at the fifth printing dated 1997. The updating that occurred in 1988 was extensive and brought the text to the forefront of knowledge in a rapidly advancing field. Therefore, at the fifth printing the question must be asked: Is the informaton contained still up to date?

The interval between the last updating has coincided with major advancements in understanding of cochlear function. The notion of active processes involving the outer hair cells and evidenced by the various forms of otoacoustic emissions has become established. The quintessential function of the hair cells to transduce vibration energy into nerve impulses is now understood much better. The author was unfortunate in that his updating was timed to occur in the early stages of this period of advancement, and he was forced to give explanations that might not pass the test of time. An example is giving the hair cell tip-links as the site of the gating channel responsible for transduction. In fact, later work has proved this to be correct.

Several new important aspects of auditory function were simply unknown at the time of writing. One is the regeneration of hair cells that has been demonstrated in the vestibular hair cells of mammals and other species and in the auditory hair cells of birds. Another is the phenomenon whereby exposure to moderate levels of sound over an extended period leads to a reduction in susceptibility to noise-induced hearing loss. Naturally, these topics are not covered. Moreover, there have been huge advances in genetics and understanding of the development of the auditory system, including understanding of genetically determined disorders. The book could usefully be extended with a chapter on development.

The final chapter covers sensorineural hearing loss and devotes several pages to electrical stimulation of the ear by cochlear implants. This is hopelessly out of date and is arguably outside the main scope of the book.

Ideally, a new edition should have been produced instead of resorting to a fifth printing of an old edition. Given that the author has not been able to devote the substantial amount of time that would have been required to generate a new edition, potential purchasers and teachers must decide whether this is still the textbook of choice on general auditory physiology. On balance, it retains that status and this reviewer continues to recommend it to postgraduate students in audiology as the primary text, with certain caveats

concerning the areas where it is no longer adequate. Nonetheless, time is running out and a new edition is needed in the near future.

M. E. LUTMAN

Vibration Control of Active Structures An Introduction, 1997, by André Preumont. London, Dordrecht, Boston: Kluwer Academic Publishers. 265 pp. Price (hard bound) NLG 225.00, $149.00, £93.00, ISBN 0-7923-4392-1

This book is the latest in a series on Solid Mechanics and Its Applications which is edited by G. M. L. Gladwell. After an introductory chapter the book is entirely devoted to feedback control of structures and is targeted at structural dynamicists who wish to learn about active structural control. Although the book is billed as an introductory text, the reader needs to be well read in both structural dynamics *and* control before tackling this book, as competency in both subject areas is assumed.

There are 259 pages in 11 chapters, and each chapter concludes with a set of problems and references. There is also a compilation of about 140 references at the end of the book. Following the Introduction, chapter 2 introduces structural dynamics in terms of a modal expansion, and chapter 3 provides a nice summary of contemporary piezoelectric actuators and sensors that can be used in an active vibration control system. Collocated control and active damping are described in chapters 4 and 5 respectively. The next two chapters discuss state-space formulation and controller design in the frequency domain with special emphasis on stability and robust controller design. Following three chapters on optimal control, controllability and observability and stability, the book concludes with a chapter describing some applications of structural control. These applications are mainly of work carried out at the author's laboratory at the Université Libre de Bruxelles.

Overall the book is well written with the analysis presented in a clear logical way. The reader is directed towards relevant references for background reading at appropriate points in the text. Readers should be aware that the author's writing style is that of a control engineer where most mathematical descriptions of structures and systems are in s-plane, and the traditional structural dynamicist may find this a little difficult to interpret in places. There is one criticism that I have concerning the notation: the book would have been much easier to read had the author used a bold, lower case font to represent vectors, and a bold, upper case font for matrices. Notwithstanding this, the book is considered to be a most useful contribution to the literature, presenting active vibration control in a slightly different way than contemporary texts on the subject. It will be of particular interest to graduate students and researchers in the field.

M. J. BRENNAN

Ultrasonic Sensors: *For Chemical and Process Plant*, 1997, by R. C. Asher. Bristol: Institute of Physics Publishing. $xx + 473$ pp. Price, hard cover, £85; $150.00. ISBN 0-7503-0361-1.

This book is written in three parts; 'Ultrasound and its properties', 'Description of ultrasonic sensors' and the Appendices. There is a good basic introduction to ultrasound,

and its uses are well catalogued and practically described. Only the bare minimum of theory is introduced. As such, it is certainly accurately pitched at the engineer who only wants to apply the methods without becoming a world expert on ultrasound. The author has quite effectively restricted himself to the (low power) sensor applications of the title, and does not deal with the domain of material modification using ultrasound; or any of the other higher power applications. Although the book is presumably aimed at the process plant engineer, there is nothing in fact that specializes the implementation of the techniques in this book to the chemical and process plant. The only real consequence of this qualification is on the range of techniques and mix of subjects covered.

The first part of the book considers ultrasound propagation within general media, through and along interfaces, and the practical aspects of conducting the ultrasound to the interface or medium where it is required. There are also chapters on the various types of ultrasound transduction mechanisms commonly used for both transmission and reception, with descriptions of a diverse assortment of transducers based on these principles. The behaviour and limits of applicability of these transducers is also discussed. In addition, there is a chapter on the electronics and signal processing associated with the use of these transducers in typical ultrasound applications.

The second part deals with applications of the various ultrasonic sensors. These include level detection, substance indentification, temperature determination, particle or droplet sizing, flow velocity measurement and sonar. The latter is taken to include the detection of echoes for the purposes of detecting and locating liquid or solid surfaces, liquid–liquid interfaces or liquid–sediment interfaces. For all of these sections there are invariably good pictorial representations of the physical setup, and often depictions of the output waveforms that are to be expected. Two chapters on attenuation, scattering and acoustic emission describe general methods that are used in some commercial devices for particle sizing, concentration determination and two-phase flow analysis. Some of the material in these chapters refers to quite complex techniques which are still only to be found in the laboratory or at most rarely in industry. This particular material serves more to alert the reader as to what might be achievable in those circumstances where some amount of experimentation may be permissible.

The third section, the appendices, deal with the specific properties of liquids, gases and mixtures that effect bulk ultrasound velocity and absorption. Concerning solids, they address the subjects of piezoelectricity and the effect of material shape on ultrasound propagation (such as modes of propagation in plates, rods and horns). It examines these subjects at a reasonably basic level. Finally there is a comprehensive list of relevant equipment and material suppliers. Most of these are referred to in the text.

As a catalogue and description of existing techniques this book is valuable. It also contains helpful references to commercial instruments that utilize the techniques described, and, so, is valuable from this point of view as well. Most issues are discussed in a practical manner, giving good rules of thumb and bounds within which the application of each technique is valid. There are also many insights arising from the cross-fertilization of ideas that sometimes accompanies reviews such as this; although these would seem to be more valuable to the researcher than the plant engineer.

Again, while the subject matter is not discussed in detail, the reader will come away with a good understanding of what may be useful for a particular situation, potential problems with the application, potential variations on the application and where commercial assistance may be sought. In all of these areas, the advice given ranges from ''common-knowledge'' to quite advanced.

B. MARTIN

Rotordynamics Prediction in Engineering (*second edition*), 1998, by M. Lalanne and G. Ferraris. Chichester: John Wiley, $xi + 254$ pp. Price (hard back) $39.95. ISBN 0-471-97288-6

Although the prediction of the analysis of the response of rotating machines is of vital importance to many industries, there are few books on the subject. This book is the second edition; the first edition was published in 1990 and reviewed by A. G. Parkinson in 1991 (*Journal of Sound and Vibration*, **147**, 547–548). The second edition is a minor revision of the first. A chapter on simple models of multirotors has been added, different industrial case studies have been considered and a more detailed description of the computer program included. The authors' target audience for the book are engineers and undergraduate and graduate students, and the authors' indicate that background knowledge in rigid body mechanics, strength of materials, matrix calculations, differential equations and mechanical vibrations is required. In reality the reader requires a sound knowledge of multi-degree of freedom vibration analysis, energy methods and finite element analysis. If the reader has this knowledge then the extra modelling and analysis required for rotating machines is presented in a concise style. However, this style is not one that every reader will find attractive.

Chapter 1 considers the basic elements of rotating systems, namely disks, shafts, bearings, seals and mass imbalance. Throughout the book the equations of motion are derived by an energy approach via Lagrange's equations. This chapter expresses the strain and kinetic energies for the components very generally, and should really be thought of as a review of requisite knowledge that is required for the subsequent chapters. This is reinforced by Lagrange's equations appearing on the first page.

Chapter 2 introduces many of the basic phenomena encountered in rotordynamics using a simple two-degree-of-freedom model of a monorotor derived via a Rayleigh-Ritz analysis. Using such a model allows many of the equations to be solved by hand, and gives great insight to many of the important phenomena. Numerical examples are given throughout the chapter to illustrate the phenomena. The Campbell diagram, the imbalance response, the response to asynchronous forcing, and the response to a stationary harmonic force are described. The concepts of forward and backward whirl, critical speeds and rotor instability are introduced and the effect of damping and bearing support asymmetry are highlighted. Chapter 3 then goes through a similar analysis for coaxial multirotors.

The element matrices of a finite element model of a rotating machine are derived in chapter 4. This chapter should be considered as a summary of the elements useful in rotordynamic modelling, as the reader really has to have a background in finite element analysis. This is confirmed by the lack of any description of how the element matrices may be assembled into global matrices. The calculation of natural frequencies, instabilities and rotor response from the matrix equations are then described. A modal reduction method, based on the undamped modes using a symmetrical stiffness matrix is developed. These methods are coded into a computer program that is described in chapter 5. The program is available over the internet, as described in Appendix B, and downloading the software is relatively straightforward. The software is DOS based, which made installation in a Windows 95 environment difficult compared to standard Windows software. The model is entered as an ASCII data file that is then processed to give the natural frequencies (including the Campbell diagram), mode shapes and the response to mass imbalance, asynchronous forces and stationary harmonic forces. Although the software works efficiently, it is a little disappointing that the user interface is not Windows based.

Chapter 6 considers the accuracy issues in the analysis and modelling of rotating machines. There is a good illustration of how the number of modes retained in the model

reduction affects the accuracy of the results. The choice of the number of shaft elements, how the disk/shaft interface can change the rotor stiffness and the calculation of the force transmitted through the bearings are addressed. The effect on the natural frequencies of changes in the bearing stiffness are considered, although the derivation of bearing characteristics is only briefly mentioned.

Seven industrial case studies are described in chapter 8. The studies cover a wide range of different machines and the range of analysis described earlier in the book. The inclusion of real studies is to be applauded, however little detail of the modelling process is described. Generally a picture of the rotor is given together with a diagram of the associated finite element mesh. No mention is made of how the detail of the actual system is transferred to the model, and the basis of any approximations are never described. Only limited remarks on the results are given.

Chapter 8 covers transient motion, particularly the run up and run down of a machine. Both the simple two-degree-of-freedom model and more complex examples are given. The effect of the speed of the run up is described. Chapter 9 considers torsional vibration using finite element models, and includes a simple example and an industrial case study. The final chapter introduces miscellaneous topics such as asymmetrical shafts and the influence of axial torque on bending vibration. Equations with periodic coefficients are briefly considered, although few readers will obtain much enlightenment from the very brief introduction to Floquet theory.

This book is a relatively minor revision of the first edition, although some improvements in notation have been made. For example, $\dot{\phi}$ is now used for the time derivative rather than ϕ^0. However there are still inconsistencies in notation, with vectors emboldened in chapter 2 and with an arrow notation in chapter 3, for example. The material gives a concise description of the analysis of rotating machines, providing the reader has sufficient prerequisite knowledge. Although the industrial case studies are impressive, an opportunity to help the reader through the modelling process has been lost. Despite this, the limited number of books describing the modelling of rotating machines means the book is essential for engineers and graduate students interested in this area.

M. I. FRISWELL