Frank Fahy and Paolo Gardonio
Academic Press, Oxford, England, 2007. 633 pp. (Softcover)
ISBN: 0-12-373633-1

It's been a long wait for the second edition of this fine text that was first published by Frank Fahy in 1985. In the past 20 plus years the discipline of structural acoustics and vibration has made enormous advances in terms of the complexities of the problems that have been tackled and solved and in terms of some of the analysis techniques that have been used. Nevertheless the first edition of this book has continued to provide much of the fundamental background and analysis tools that still underpin much of the work currently being undertaken.

In the second edition, the authors have recognised the significant advances that have been made, particularly in numerical analysis and active noise and vibration control. In fact, the last 150 pages of the book (approximately 25% of the content) are entirely devoted to these aspects with the remainder of the book representing an updated, rearranged and expanded version of the first edition, written in such a way as to ensure that the fundamental theory relevant to the numerical analysis and active control topics is well covered.

The extent of the expansion is reflected in the 630 page size of the book which is twice the size of the first edition and which includes 150 pages of new material in addition to the new material on numerical acoustics and active noise and vibration control. The second edition, like the first, has a number of problems (unfortunately fewer than in the first edition) at the end of each chapter so that readers can test their understanding of the material. Although numerical answers are given, I think that readers would find it helpful if full solutions were available somewhere on a web site. The comprehensive and extensive index will be much appreciated by readers using the book as a reference.

Chapter 1, Waves in Fluids and Solid Structures, introduces the reader to the discipline of structural acoustics, or vibroacoustics as it is sometimes referred to. The required mathematical analysis tools and the fundamental theory that underpins the process of acoustic interaction between solid structures and fluids are described using waves travelling in beams, plates and cylinders as illustrations. Wave interaction at interfaces between different media and between different types of structure is discussed in detail and probabilistic modelling is outlined as a basis for the section on statistical energy analysis in chapter 7. In addition, the duality of wave and modal descriptions of the same phenomena are discussed.

Chapter 2, Structural Mobility, Impedance, Vibrational Energy and Power, is new to the second edition. In the first edition it had been part of Chapter one but in this second edition, the treatment has been greatly expanded so that occupies a chapter on its own. This chapter is concerned primarily with the concepts of structural impedance and mobility and again beams, plates and cylinders are used as examples to illustrate the concepts. The duality between wave motion and modal analysis to describe structural vibration that was first introduced in chapter 1 is reinforced in chapter 2 using waves in beams, plates and cylinders as examples.

Chapter 3, Sound Radiation by Vibrating Structures, is concerned with developing expressions that relate the vibration velocity of a structure to the sound pressure at a location in the medium surrounding the structure and also the total radiated sound power. Basic source types are considered, such as a monopole, a baffled piston, vibrating plates (including stiffened and sandwich plates), curved shells and irregularly shaped bodies. This is the largest chapter in the book and includes over 100 pages of detailed analysis and derivations from first principles. Anyone working in the structural acoustics field would gain additional insights from this extremely comprehensive treatment.

Chapter 4, Fluid Loading of Vibrating Structures, is concerned with an analysis of the force field that a fluid exerts on a vibrating structure immersed in the fluid, with the intention of determining the influence that the fluid has on the structural vibration. The concept of complex radiation impedance is introduced and applied to the analysis of bounded and unbounded flat plates. The analysis of the effects of fluid loading on the natural frequencies and sound radiation characteristics of point excited plates and circular cylindrical shells is discussed in detail.

Chapter 5, Transmission of Sound through Partitions, is the second largest chapter and contains a very detailed and comprehensive treatment of the transmission of sound through plane, single and double leaf partitions. Normally incident, obliquely incident and diffusely incident sound fields are all considered in detail. A single panel of infinite extent is considered first to illustrate the transmission mechanisms. This is followed by an analysis of the transmission through finite size panels, a partition between two rooms, and an infinite double leaf panel (including the effects of cavity absorption and intermediate frames). Unfortunately the authors omitted an analysis of the effect of finite size on the transmission characteristics of double leaf partitions. However, such an analysis would be very complex and reference to some experimental data from other authors is adequate, given that the principles of sound transmission and trends due to such things as sound absorbing material in the cavity and the presence of intermediate frames or studs are similar for finite size partitions. Stiffened, multi-layer and composite panels are considered in a more qualitative way with performance data presented for some representative constructions,

especially those used in the automotive industry. The chapter concludes with a discussion of close fitting enclosures followed by a discussion of sound transmission through thin-walled circular cylindrical shells and pipes, with both exterior excitation and interior excitation considered.

Chapter 6, Acoustically Induced Vibration of Structures, is concerned with situations where the acoustically induced vibration of structures is such that the integrity of the structure may be at risk. The principle of reciprocity is introduced and illustrated by showing the relationship between the response of a structure to incident sound and its sound radiation characteristics. The general principles of acoustically induced vibration are illustrated using a baffled plate subject to incident plane waves. The chapter concludes with an example of how the analysis may be applied to estimating the absorption coefficients of plane surfaces inside buildings, such as wooden panels. Perhaps this chapter could have been improved by analysing the excitation due to point and line sources, both onand off-axis and the analysis of the response of cylindrical structures, as these situations more accurately reflect the case of launch vehicle excitation by rocket motors, a problem which the authors state that this chapter is directed at.

Chapter 7, Acoustic Coupling between Structures and Enclosed Volumes of Fluid, is an extension of the work of chapters 3 and 4, where it was assumed that the fluid into which the structure was radiating was unbounded. In this chapter, it is assumed that the enclosing fluid is itself enclosed and that the enclosure may partly consist of the radiating structure. A simple 1D case of a piston in a closed tube is considered first of all and this is followed by a general discussion of harmonic sound fields in an enclosed volume of fluid. The modal interaction model for low frequency or single frequency excitation and analysis is discussed followed by an introduction to the concepts of statistical energy analysis for the analysis of broadband, mid to high frequency response. The final two sections of this chapter are concerned with wave propagation in a parallel plate system, followed by wave propagation in fluid filled circular tubes. In the parallel plate analysis, the authors make the observation that taking into account the presence of fluid outside the sandwich would considerably complicate the wave propagation behaviour, which is why it is excluded even though the authors state that it would be mathematically straightforward. Even so, it would have been useful if a brief outline of this analysis had been included.

Chapter 8, Introduction to Numerically Based Analyses of Fluid-Structure Interaction, is concerned with the topics of finite element analysis and boundary element analysis, both of which are numerical approaches that may be used to solve complex problems for which analysis from first principles is either impractical or impossible. The first part of the chapter provides the theoretical concepts that underpin finite element analysis and a number of examples (including coupled fluid structure analysis) are used to illustrate how problems are formulated. The last part of the chapter is concerned with the boundary element method formulation and again the theoretical concepts underpinning this method are presented in detail. The theoretical concepts presented in this chapter are sufficient for the reader to develop a rudimentary FEA or BEM software package. However, as there are many packages available (including commercial packages and open source software), the chapter will serve more for providing users of these packages with some understanding of the underlying principles that are embodied in the software.

Chapter 9, Introduction to Active Control of Sound Radiation and Transmission, describes and explains how to apply active control to reduce the low frequency vibration and sound radiation from vibrating structures. The level of vibration reduction to be expected in various situations is illustrated by example for both feedforward and feedback approaches and for both singleinput single-output and multi-input multi-output systems. The underlying theory is presented concisely and various types of sensors and actuators are described. The reader would need some understanding of control theory to fully appreciate this chapter and as would be expected in a book of this type. There is a lack of guidance needed for the design and practical implementation of an active control system, but this does not detract from the huge value of this chapter in guiding the reader through the concepts and principles underlying the design and operation of such systems.

This book is an outstanding contribution to the acoustics and vibration literature. Although it is written at an advanced level, almost anyone undertaking serious work in acoustics or vibration is sure to learn something of value by reading it. However, for researchers and PhD students working in acoustics and vibration, it is an essential reference and well worth the cost.

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