

Preface

Noise pollution is an environmental problem. Structures excited by dynamic forces radiate noise. The art of noise reduction requires an understanding of vibro-acoustics. This topic describes how structures are excited, energy flows from an excitation point to a sound radiating surface, and finally how a structure radiates noise to a surrounding fluid. The aim of this text is to give a fundamental analysis and a mathematical presentation of these phenomena. The text is intended for graduate students, researchers and engineers working in the field of sound and vibration.

Part of the text has evolved from an advanced course on acoustics initially given at Chalmers University, Sweden, in the early nineteen seventies. Over the years, these lectures were transformed to MSc and Ph.D. courses on vibro-acoustics. These courses were given at MWL, KTH, Sweden. During the years, much material has been added as inspired by research work, colleagues and Ph.D. students at many of the universities and research institutes I have been fortunate enough to be associated with.

The main text is published as two volumes. There are eight chapters in each volume. A number of problems is given at the end of each chapter. The solutions to the problems plus a summary of the main formulae are presented in a third volume. In the text, frequent references are made to the behaviour of simple vibratory systems and their response in the frequency domain. Therefore and for the sake of completeness, though well-known to the reader, the first chapter includes discussions of simple one degree of freedom systems. In this way, energy and power of simple vibratory systems are introduced. Various types of losses are discussed. In the second chapter the vibration of linear mechanical systems is studied in the frequency domain. In particular, the response of systems excited by harmonic and random forces is analysed. In Chap. 3, the basic differential equations governing longitudinal, transverse and bending waves are discussed. The equations are derived based on the concept of stresses and strains in solids. Energy stored and energy flow in structures caused by the various wave types are analysed. The general wave equation is introduced in Chap. 4. This equation is shown to govern all elastic motion of a solid. The generalised wave equation is utilized to describe

the bending of thick plates, sandwich beams and I-beams. It is demonstrated that in-plane waves like longitudinal and transverse waves are strongly coupled. In Chap. 5, it is shown that in-plane and bending waves also are well coupled. As presented, waves are attenuated by internal losses and added damping. More importantly, any discontinuity or junction will influence the energy flow in a structure. A number of examples are given. Measurement techniques to determine losses across junctions are introduced. Chapter 6 deals with longitudinal waves in finite beams. Eigenfunctions and eigenvalues are discussed for various boundary conditions. The results are used to model free and forced vibrations of beams. Green's function is derived for some cases and used for the calculation of the forced response of beams. The mobility concept is used to determine the response of coupled systems. In addition, the transfer matrix system is introduced. Flexural vibrations of finite beams are discussed in Chap. 7. Again, eigenfunctions and eigenvalues are derived for a number of boundary conditions. Free and forced vibrations are considered. The free and forced vibration of isotropic rectangular and circular plates is investigated in Chap. 8. The responses of structures excited by random and harmonic forces are compared. The mobility concepts of finite and infinite plates are investigated, and simplified models for the calculation of the energy of plates are introduced.

Chapter 9 in Volume II is on variational methods. The variational technique is used for the derivation of equations governing the vibration of sandwich and other composite elements and some simple shell elements. In the following Chap. 10, the coupling between mechanical systems is explored. This includes an introduction to the vibration of rubber mounts, resilient mountings and the design of foundations. The topics of Chap. 11 are waves in fluids including discussions on various types of monopole, dipole and multipole sources. Also included are out-door and room acoustics. Chapter 12 is on fluid structure interaction and radiation of sound. Sound radiation from infinite and finite plates as well as the fluid loading on structures are investigated. Chapter 13 is on sound transmission loss of panels. The sound transmission through infinite and finite panels is discussed. The influence of boundary conditions and geometry of transmission rooms on the measured and predicted sound transmission loss is illustrated. The title of Chap. 14 is Waveguides. In this chapter the prediction and reduction of energy flow in structural waveguides typical for ship, aircraft and train constructions are investigated. Also included are discussions on energy flow and sound transmission through composite structures and shells. In particular, the prediction of sound transmission loss of aircraft structures is highlighted. The contents of Chap. 15 include random excitation of structures and flow induced vibrations. Both phenomena are of importance for interior noise in aircraft, ships and fast trains. Finally, Chap. 16 is on the prediction of velocity and noise levels in large structures like vehicles. The basic concept of the Statistical Energy Analysis is presented. Predictions based on the waveguide technique are also illustrated in the same chapter.

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