Preface

Low noise constructions receive increasing attention in highly industrialized countries. Consequently, control of noise emission challenges a growing community of engineers. Classically, noise emission is controlled experimentally utilizing the trial and error method and engineering experience. The development of numerical methods such as the finite element and the boundary element method for low frequency acoustic problems and statistic methods for high frequency problems allows simulation of radiation and scattering from arbitrary geometric objects.

For low and medium frequency problems, classical approaches for solution of problems of acoustics favor analytical methods including Fourier series approaches. These approaches are quite powerful and they are still developed further. In particular, if orthogonal eigenfunctions are used as the basis functions of the Fourier series, they converge rapidly. However, if the geometry of the radiator or scatterer becomes more complicated, Fourier series become impractical to use. In these cases, numerical methods can be used more conveniently. The easiest and most straightforward approach consists of the finite difference method. However, finite difference methods suffer from a number of specific problems such as mesh restrictions and dispersion. Alternatively, finite element and boundary element methods use a more complicate mathematical formulation but can be applied in a very general way.

This book deals with finite element and boundary element methods for acoustic problems. Although, the title contains the restriction of the acoustics of fluids, a number of chapters consider solid structures as well. The edition comprises 21 chapters. The first one, i.e. Chapter 0, is a concept chapter. It starts with the derivation of the harmonic wave equation from the fundamental relations of continuum mechanics. It is followed by ten chapters on finite element methods and another ten chapters on boundary element methods. The reader is referred to Chapter 0 and Section 0.6, cf. pages 20–22, to survey the remaining chapters and discuss them related to the formulations which are given in Chapter 0.

This is a book on numerical methods. In the first volume of his series *The Hitchhiker's Guide to the Galaxy*,[2] Douglas Adams formulates "the ultimate answer to life, the universe, and everything." It is a numeric solution: 42, evaluated by the computer Deep Thought. A CPU time of $\approx 2.37 \times 10^{14}$ seconds (7.5 Million years) was required to achieve this interesting result. This book on numerical methods contains contributions written by 42 authors. The number of 42 might indicate that it covers a wide range of topics of computational acoustics. However, the reader should not expect the ultimate answer to the problems of computational acoustics in general. It took the editors ≈ 20 months ($\approx 5.2 \times 10^7$ seconds) of manual work from the idea to the final version of the book. There are many reasons why this book has been completed much faster than the evaluation of Deep Thought. Maybe this was achieved because the overall content is less general than the ultimate answer to life, the universe, and everything. Probably, the major reason for the successful and efficient completion consists in the willingly collaboration of all authors to supply the editors with their contributions. The editors wish to acknowledge that it has been their great pleasure to work together with all authors.

A number of other persons have been relevant for the successful completion of this edition. First of all, we wish to mention Eva Hestermann–Beyerle of the Springer–Verlag in Heidelberg. It is worth mentioning that she encouraged the editors to start with their editorial work. Moreover, Eva Hestermann–Beyerle has continuously supervised the progress of the edition and provided the editors with numerous valuable advice.

The editors wish to thank their close colleagues at the Institute of Solid Mechanics at Technische Universität Dresden and at the Federal Armed Forces Underwater Acoustics and Marine Geophysics Research Institute for their patience and their support. There are many others who contributed to the successful completion of this work. It seems to be impossible to mention all of them. However, the editors are very thankful for every single assistance in during the preparation of this book.

Dresden and Kiel,
October 2007

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[2] Douglas Adams' *The Hitchhiker's Guide to the Galaxy* was originally published in 1979 by *Pan Books Ltd., London.*

Contents

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