Preface

The material presented in this *Handbook* has grown out of lecture notes of the courses *Radiation and Scattering of Acoustic Waves in Fluids*, *Radiation and Scattering of Elastic Waves in Solids* and *Radiation and Scattering of Electromagnetic Waves* taught at the Delft University of Technology in the curricula of the Departments of Electrical Engineering, Engineering Mathematics, Mining and Petroleum Engineering, Applied Physics and Civil Engineering, and in the graduate courses provided by the Delft Centre for Technical Geoscience. A standard introductory knowledge of differential and integral calculus, as well as some undergraduate physics, is preassumed, while an introductory notion of Laplace and Fourier transformation methods is also helpful. Should the reader need to refresh his or her understanding of these concepts, the necessary mathematical prerequisites are recapitulated in the appendices that also include a number of results needed in the main text.

In view of the ever-increasing number of applications where wave problems are modelled for realistic three-dimensional configurations on large-capacity high-speed digital computers, the emphasis is mainly put on general principles and theorems that can serve to check numerical results rather than on highly specialized configurations for which more or less complicated analytical answers can be obtained. With this type of application in mind, the subscript notation for Cartesian vectors and tensors is consistently used as an interdisciplinary notational tool. This notation has the advantage that expressions and equations can be copied almost effortlessly to produce the corresponding statements in any of the high-level programming languages (for example, Fortran 77 or Fortran 90), while they are also directly amenable to symbolic manipulation with programs like Mathematica™. Another advantage of the subscript notation is that the common structure of the wave and field equations in different branches of physics, and of the theorems resulting from them, becomes immediately clear. Moreover, the notation enables one to take into account anisotropy in the media in which the waves propagate.

The analysis is carried out in parallel in both the time domain and in the complex frequency domain where the time coordinate has been replaced by the complex Laplace transform parameter. The physical requirement of causality of the wave motion is conveniently accounted for through this procedure. Furthermore, the expressions pertaining to the steady-state quantities for a fixed frequency of oscillation result from the imaginary values of the time Laplace transform. The major steps in the time-domain and the complex frequency-domain analyses are presented in both these domains, thereby allowing a choice between either of the two in classroom use if the time allotted is curtailed.

Another important feature is the emphasis on reciprocity as one of the most fundamental properties of fields and waves. It is shown how, amongst others, the direct (forward) source problem, the direct (forward) scattering problem, the inverse source problem and the inverse scattering problem can be formulated in a natural manner with reciprocity as the point of departure, and the setup also reveals that all known algorithms for the computational analysis of these problems are consequences of a proper choice and interpretation of the two Field States that occur in the reciprocity theorems.

A set of carefully selected Exercises forms an integral part of the text. The exercises are hardly ever of the substitution-of-numbers type. They often illustrate the models that underlie the physics of the problem or cover additional aspects of the subject in question. They are placed at the end of each section and all answers are provided.

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