Preface

Efficiency of the Green's function instrument is commonly recognized and as a result, its use is frequently recommended in the qualitative analysis of boundary value problems for ordinary as well as partial differential equations. Nowadays, this instrument has been transformed into a powerful investigative tool that has been around for almost two centuries since its introduction by a brilliant British mathematician and physicist, George Green. His elegant elaborations had revealed impressive constructive properties of Green's functions.

It would have been quite a misconception to presume that the realm of implementations of Green's functions is exclusively limited to pure theoretical aspects. As it has been corroborated by numerous recent works in applied mathematics, these functions possess a remarkable computational potential as well. It has been repeatedly demonstrated that Green's functions are extremely helpful in the development of numerical algorithms for a vast variety of applied problems.

The aim of this book is to demonstrate the computational effectiveness of Green's functions in solving a class of complex engineering problems that are simulated with specific partial differential equations.

In order to pave the way for a reliable exploitation of constructions and machines, an engineer who is involved in the design aspects, has to take into account a great deal of various physical factors under which structures work. In this regard, it is quite often the case that engineers are specifically concerned with potential (thermal, magnetic, etc.) fields induced by various sources in thin-wall construction elements.

Potential fields in thin-wall construction elements can adequately be simulated by boundary value problems posed for the two-dimensional Laplace equation written in geographical coordinates associated with middle surfaces of those elements. Regarding the term *Laplace equation*, we will use it conditionally in this context and in reference to an elliptic two-dimensional variable coefficients partial differential equation whose governing operator is obtained from the standard three-dimensional Laplacian by a relevant change of independent variables.

The present monograph concentrates on just a single fragment of the investigation mentioned above. The intention is to summarize our earlier elaborations in the area of construction of readily computable representations for Green's functions and matrices of Green's type for a specific class of applied problems *never touched upon before in classical texts*. Boundary value problems that simulate potential fields induced in thin-wall structures is our focus.

At the same time, we have to highlight an unfortunate aspect which holds engineers hesitant to implement the Green's function tool in their computational work. This reluctance is due to a lack of compact representations of these functions for partial differential equations which are ready for immediate computer use. This makes potential users somewhat cautious as to the practical implementation of Green's function-based methods in the field of numerical research.

Intensive efforts have been undertaken in recent decades to address the foregoing aspect. The focus has been on the enhancement of the computational effectiveness of Green's functions aiming at the improvement, to a reasonable extent, of their 'reputation' within the engineering community. As a result, some efficient techniques have been proposed for the construction of computer-friendly forms of Green's functions to a number of applied partial differential equations.

This book may be useful as a supplementary text for upper-level undergraduates or graduates in applied mathematics or relevant disciplines. Engineers, who are involved with the design of constructions, will also benefit from reading this volume.

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The finishing stage of this book fell at the time of the first author's sabbatical leave at the Azerbaijan ADA University, Baku. Our appreciation goes to the Rector of this institution, Ambassador Hafiz Pashayev who created a comfortable environment for the productive work.

We have also been very fortunate to receive high-quality support from the Springer editors, Elizabeth Loew and Ann Kostant. Their professionalism combined with their friendly attitude allowed us to smoothly navigate through a number of reefs within the editorial stage of our work.

As to possible flaws in this volume, we recall a joke which was popular among computer users years and years ago. The joke was formulated as an axiom claiming that any computer program, of whatever length and complexity, contains at least one error. So, any errors the reader finds are ours, and ours alone. All criticisms and comments, aiming at the improvement of this work, are welcome and will be gratefully received.

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