Preface

In May 2012, the International Centre for Mathematics Sciences (ICMS) in Edinburgh hosted the workshop *Boundary Value Problems for Linear Elliptic and Integrable PDEs: Theory and Computation*. This workshop brought together a small group of mathematicians interested, from several different perspectives, in the solution of boundary value problems, namely the type of problems modeled by partial differential equations (PDEs) that are most commonly arising in applications.

This meeting focused in particular on the applications of the so-called *unified transform* (also referred to as the *Fokas transform* or the *method of Fokas*) to the analysis and numerical modeling of boundary value problems for linear and integrable nonlinear PDEs and on the closely related *boundary element method*, a well-established numerical approach for solving linear elliptic PDEs. The latter method can be viewed as the counterpart in the physical space of the numerical implementation of the unified transform, which is formulated in the spectral (Fourier) space.

This book was conceived during the workshop mentioned above and collects the results of the exchanges of ideas fostered by the meeting. The chapters are closely related and, when put together, paint a picture of the state of the art in the advances and applications of the unified transform as well as its relation with the boundary element method.

It is divided in three main parts. Part I contains new theoretical results on evolution and elliptic problems, linear and nonlinear. New explicit solution representations for several classes of boundary value problems are constructed and rigorously analyzed.

Part II, at the center of the book, is a detailed overview of variational formulations for elliptic problems, building up to placing the unified transform approach in this classical context, alongside the boundary element method, and stressing its novelty.

Part III presents recent numerical applications based on the boundary element method and on the unified transform.