Preface

This textbook is intended to serve a course on mathematical methods of physics that is often taken by graduate students in their first semester or by undergraduates in their senior year. I believe the most important topic for first-year graduate students in physics is the theory of analytic functions. Some students may have had a brief exposure to that subject as undergraduates, but few are adequately prepared to apply such methods to physics problems. Therefore, I start with the theory of analytic functions and practically all subsequent material is based upon it. The primary topics include: theory of analytic functions, integral transforms, generalized functions, eigenfunction expansions, Green functions, boundary-value problems, and group theory. This course is designed to prepare students for advanced treatments of electromagnetic theory and quantum mechanics, but the methods and applications are more general. Although this is a fairly standard course taught in most major universities, I was not satisfied with the available textbooks. Some popular but encyclopedic books include a broader range of topics, much too broad to cover in one semester at the depth that I thought necessary for graduate students. Others with a more manageable length appear to be targeted primarily at undergraduates and relegate to appendices some of the topics that I believe to be most important. Therefore, I soon found that preparation of lecture notes for distribution to students was evolving into a textbook-writing project.

I was not able to avoid producing too much material either. I usually chose to skip most of the chapter on Legendre and Bessel functions, assuming that graduate students already had some familiarity with them, and instead referred them to a summary of the properties that are useful for the chapter on boundary-value problems. Other instructors might choose to omit the chapter on dispersion theory instead because most of it will probably be covered in the subsequent course on electromagnetism, but I find that subject more interesting and more fun to discuss than special functions. The chapter on group theory was prepared at the request of reviewers; although I never reached that topic in one semester, I hope that it will be useful for those teaching a two-semester course or as a resource that students will use later on. It may also be useful for one-semester courses at institutions where the average student already has a sufficiently strong mastery of analytic functions that the first couple of chapters can be abbreviated or omitted. I believe that it should be possible to cover most of the remaining material well in a single semester at any mid-level university. I assume that the calculus of variations will be covered in a concurrent course on classical mechanics and that the students are already comfortable with linear algebra, differential equations, and vector calculus. Probability theory, tensor analysis, and differential geometry are omitted.

A CD containing detailed solutions to all of the problems is available to instructors. These solutions often employ *Mathematica* to perform some of the routine but tedious manipulations and to prepare figures. Some of these solutions may also be presented as additional examples of the techniques covered in this course.