

Preface

The main purpose of this book is to introduce and explore a variety of mathematical methods useful for analyzing equations arising in the modeling of phenomena from the natural and engineering sciences. The book is intended for students beginning their third year of undergraduate work in one of these sciences. Students will reap maximum benefit from the book if they bring to it knowledge gained from having taken the following courses: one year of general physics, including an introduction to the essential issues of modern physics; a standard three semester course in calculus; an introductory course in differential equations; and a one semester course in linear algebra. This book is based on my experiences related to teaching courses of “mathematical physics” and “quantum mechanics” for over twenty-five years at Fisk University, Atlanta University, and Clark Atlanta University; and from presenting the results of my research activities to both undergraduate and graduate students at numerous workshops and seminars. These experiences led me to the following conclusion: It is generally of greater utility to make science and engineering students aware of the existence of a broad range of mathematical techniques, needed to solve the equations arising in their work, both academically and professionally, than it is to give the intimate details of a few methods within the framework of a rigorous theorem and proof format. Clearly, the huge success of the natural and engineering sciences has been based largely on this philosophy.

Most textbooks on the subject of mathematical methods and their applications tend to be encyclopedic in both size and coverage, and, in general, have much more material than can be presented in one year. The topics of this book can be covered in two semesters, and most chapters can be read independently of each other. However, the order given is usually the one I use in my teaching this course.

While we present many theorems and related results in rigorous mathematical form, in general, few proofs are explicitly given. However, we do provide for each chapter a list of books and related publications which give such proofs and/or alternative ways of stating the theorems.

An important aspect of this book is the inclusion of a rather large number of worked examples. They are worked in sufficient detail such that the reader can fully understand the concept or method under discussion. In general, the reader/student should work all of the problems listed at the end of each chapter. Their solution not only allows the filling in of certain gaps, but often they show how a particular concept or method can be generalized or extended to other situations.

Another feature of the book is that it gives equal emphasis to both qualitative and quantitative methods. In particular, much of the presentation concerns the use of various “asymptotic methods” to determine analytical approximations to the solutions for both differential equations and certain functions defined by integrals. A good starting point for a course, based on this book, is to begin with a general, but, quick review of the material presented in the two appendices.

The writing of this book has been both a learning and “fun” experience for me. It will be of great value to me and persons who may use this book if you, as a reader/user, report to me any “errors” that you find. In particular, I welcome any comments as to how the presentation on any topic can be improved (within the framework of keeping the book finite). My contact information is

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