Preface

This book is intended to provide sufficient material for a three-hour one-semester course in the theory of differential and integral equations, and is addressed primarily to undergraduate students at the intermediate level.

Usually, any elementary course provides enough material related to the algorithmic aspects of theory (how to solve an equation). In such a course, many classes of equations are solved by means of formulas, using series expansions, Laplace transform, etc. Also, one finds various motivations and illustrations from physics, engineering science, and related fields. Yet, only rarely does the reader find in an elementary course some comments concerning the general problem of existence, the uniqueness problem, the behavior of solutions, and several other properties that are interesting in themselves or with respect to their applications.

The aim of this book is to offer a discussion of the fundamental concepts in the theory of differential and integral equations, with a view toward preparing the reader for graduate-level courses on advanced topics. This book can also serve a graduate-level course for non-mathematics majors. Students of various disciplines have found an increasing need to study such topics as control theory and systems theory, which are mainly based on differential equations, integral operators, and related concepts. The material included in this text will provide sufficient basis for understanding these new areas of investigation.

The prerequisites are a good course in advanced calculus (set theory and elementary topological concepts, properties of continuous functions,

uniform convergence, implicit functions), some preparation in linear algebra, and a reasonable acquaintance with elementary complex analysis (including entire and meromorphic functions). No prerequisite is needed in differential or integral equations! Indeed, the book can be used as a first course in differential and integral equations by any reader possessing knowledge of the above-mentioned fields.

To aid the reader, the text includes several auxiliary results from algebra and calculus, some with complete proofs and the others with adequate references. Each chapter ends with a number of problems. Very often these problems are quite challenging, representing extensions of the theory beyond the level reached in the text rather than standard applications of some formulas or theorems.

Despite the fact that by their inner structure the two theories to which this book is dedicated are quite different, hopefully the reader will not be shocked in passing from one subject to the other. Thus, the theory of Volterra integral equations appears as a direct continuation of the theory of ordinary differential equations. Moreover, some topics used in the theory of differential equations apply to Fredholm integral equations, and the most salient results in the theory of integral equations with symmetric kernel lead to an elegant solution of boundary value problems for ordinary differential equations (Sturm-Liouville problems).

Finally, use of the Lebesgue integral was avoided—not because this tool would be useless in studying differential or integral equations but because it is unwieldy for many students.

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