

Preface

The aim of this book is to provide a practical working tool for students in Engineering, Mathematics, and Physics, or in any other field where rigorous Calculus is needed. The emphasis is thus on problems that enhance students' skill in solving standard exercises with a careful attitude, encouraging them to devote an attentive eye to what may or may not be done in manipulating formulae or deriving correct conclusions, while maintaining, whenever possible, a fresh approach, that is, seeking guiding ideas.

Every chapter starts with a summary of the main results that should be kept in mind and used for the exercises of that chapter; this is followed by a selection of guided exercises. The theoretical preamble is meant to recapitulate the main definitions and results and should also offer a bird's-eye view on the topic treated in the chapter. Hence, the student can quickly review the main theoretical facts and then, most importantly, "learn by examples," becoming acquainted with the specific techniques by seeing them applied directly to the problems. Each exercise ends with a short comment which underlines the main issues of that specific exercise, the leading ideas, and the main techniques. A selection of problems closes each chapter, the answers to which are all listed in Solutions. The reader is urged to try to solve some of these problems, which are similar, but not always trivially analogous, to those that have been presented in detail. Mathematics is never just an application of rules, but requires understanding, clear thought, and a bit of imagination. A different problem, a new question, a slightly skew formulation: this is where one really begins to master a technique and to consolidate it. So, rather than feeling discouraged, the student should develop curiosity and be aware that any significant progress does require some effort, and a little sweat is really part of the game.

Perhaps the most distinctive feature of this book is that our approach is very direct and refers to a concrete experience. The material is in fact mostly taken from actual written tests that have been delivered in the years 2000–2013 at the Engineering School of the University of Genova. Literally, thousands of students have worked on these problems, so our first and foremost acknowledgment goes to them, because they have helped us greatly over the years, tuning our views and

letting us see where the main difficulties really are, those that need both clear statements and specifically designed exercises. Their fellow colleagues, the present and future students, are of course our public and our intended readers. Some complementary standard material has also been added, especially where the main thrust is in the direction of unraveling the details of basic techniques and achieving a reasonably complete panorama of possible scenarios.

The book ends with a chapter of problems that are not designed with a single issue in mind but rather require a variety of techniques, and should perhaps be addressed as a final check on the global preparation. Indeed, they have all been assigned in written tests and have all been worked on by large numbers of students. Intentionally, no solutions are given or even hinted at, and they are not ordered according to increasing difficulty. The student who wants to challenge him- or herself with questions that many other students have faced as a final exam should look with particular interest at Chap. 16.

The topics covered are those that are typically taught in a first-year engineering undergraduate Calculus course in Italy, with possible variants. The basic focus is on functions of one real variable. As for basic ordinary differential equations, separation of variables, linear first-order, and constant coefficients ODEs are discussed.

We believe that anyone who can solve the suggested problems with a reasonable degree of accuracy is in a safe position to achieve a positive result in most Italian universities. Our international experience also tells us that the same may be claimed for most universities around the world, for undergraduate Calculus or Advanced Calculus.

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Calculus Problems

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