Preface

The successful preparation of engineering students, regardless of specialty, depends heavily upon the basics taught in the junior year. The general mathematical ability of students at this level, however, often forces instructors to simplify the presentation. Requiring mathematical content higher than simple calculus, engineering lecturers must present this content in a rapid, often cursory fashion. A student may see several different lecturers present essentially the same material but in very different guises. As a result "engineering mathematics" often comes to be perceived as a succession of procedures and conventions, or worse, as a mere bag of tricks. A student having this preparation is easily confounded at the slightest twist of a problem. Next, the introduction of computers has brought various approximate methods into engineering practice. As a result the standard mathematical background of a modern engineer should contain tools that belonged to the repertoire of a scientific researcher 30–40 years ago. Computers have taken on many functions that were once considered necessary skills for the engineer; no longer is it essential for the practitioner to be able to carry out extensive calculations manually. Instead, it has become important to understand the background behind the various methods in use: how they arrive at approximations, in what situations they are applicable, and how much accuracy they can provide. In large part, for solving the boundary value problems of mathematical physics, the answers to such questions require knowledge of the calculus of variations and functional analysis. The calculus of variations is the background for the widely applicable method of finite elements; in addition, it can be considered as the first part of the theory of optimal control. Functional analysis allows us to deal with solutions of problems in more or less the same way we deal with vectors in space. A unified treatment of these portions of mathematics, together with examples of how to exploit them in mechanics, is the objective of this book. In this way we hope to contribute in some small way to the preparation of the current and next generations of engineering analysts. The book is introductory in nature, but should provide the reader with a fairly complete picture of the area. Our choice of material is centered around various minimum and optimization problems that play extremely important roles in physics and engineering. Some of the tools presented are absolutely classical, some are quite recent. We collected this material to demonstrate the unity of classical and modern methods, and to enable the reader to understand modern work in this important area.

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