PREFACE

The objective of this book is to provide a mathematical text at the third year level and beyond, appropriate for students of engineering and sciences. It is a book of applicable mathematics. We have avoided the approach of listing only the techniques followed by a few examples, without explaining why the techniques work. Thus we have provided not only the know how but also the know why. Equally it is not written as a book of pure mathematics with a list of theorems followed by their proofs. Our emphasis is to help students develop an understanding of mathematics and its applications. We have refrained from using clichés like "it is obvious" and "it can be shown", which might be true only to a mature mathematician. In general, we have been generous in writing down all the steps in solving the example problems. Contrary to the opinion of the publisher of S. Hawking's book, *A Short History of Time*, we believe that, for students, every additional equation in the worked examples will double the readership.

Many engineering schools offer little mathematics beyond the second year level. This is not a desirable situation as junior and senior year courses have to be watered-down accordingly. For graduate work, many students are handicapped by a lack of preparation in mathematics. Practicing engineers reading the technical literature, are more likely to get stuck because of a lack of mathematical skills. Language is seldom a problem. Further self-study of mathematics is easier said than done. It demands not only a good book but also an enormous amount of self-discipline. The present book is an appropriate one for self-study. We hope to have provided enough motivation, however we cannot provide the discipline!

The advent of computers does not imply that engineers need less mathematics. On the contrary, it requires more maturity in mathematics. Mathematical modelling can be more sophisticated and the degree of realism can be improved by using computers. That is to say, engineers benefit greatly from more advanced mathematical training. As Von Karman said: "There is nothing more practical than a good theory". The black box approach to numerical simulation, in our opinion, should be avoided. Manipulating sophisticated software, written by others, may give the illusion of doing advanced work, but does not necessarily develop one's creativity in solving real problems. A careful analysis of the problem should precede any numerical simulation and this demands mathematical dexterity.

The book contains ten chapters. In Chapter one, we review freshman and sophomore calculus and ordinary differential equations. Chapter two deals with series solutions of differential equations. The concept of orthogonal sets of functions, Bessel functions, Legendre polynomials, and the Sturm Liouville problem are introduced in this chapter. Chapter three covers complex variables: analytic functions, conformal mapping, and integration by the method of residues. Chapter four is devoted to vector and tensor calculus. Topics covered include the divergence and Stokes' theorem, covariant and contravariant components, covariant differentiation, isotropic and objective tensors. Chapters five and six consider partial differential equations, namely Laplace, wave, diffusion and Schrödinger equations. Various analytical methods, such as separation of variables, integral transforms, Green's functions, and similarity solutions are discussed. The next two chapters are devoted to numerical methods. Chapter seven describes methods of solving algebraic and ordinary differential equations. Numerical integration and interpolation are also included in this chapter. Chapter eight deals with numerical solutions of partial differential equations: both finite difference and finite element techniques are introduced. Chapter nine considers calculus of variations. The Euler-Lagrange equations are derived and the transversality and subsidiary conditions are discussed. Finally, Chapter ten, which is entitled Special Topics, briefly discusses phase space, Hamiltonian mechanics, probability theory, statistical thermodynamics and Brownian motion.

Each chapter contains several solved problems clarifying the introduced concepts. Some of the examples are taken from the recent literature and serve to illustrate the applications in various fields of engineering and science. At the end of each chapter, there are assignment problems labeled a or b. The ones labeled b are the more difficult ones.

There is more material in this book than can be covered in a one semester course. An example of a typical undergraduate course could cover Chapter two, parts of Chapters four, five and six, and Chapter seven.

A list of references is provided at the end of the book. The book is a product of close collaboration between two mathematicians and an engineer. The engineer has been helpful in pinpointing the problems engineering students encounter in books written by mathematicians.

We are indebted to many of our former professors, colleagues, and students who indirectly contributed to this work. Drs. K. Morrison and D. Rodrigue helped with the programming associated with Chapters seven and eight. Ms. S. Boily deserves our warmest thanks for expertly typing the bulk of the manuscript several times. We very much appreciate the help and contribution of Drs. D. Cartin , Q. Ye and their staff at World Scientific.

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