
Preface

This book provides a concise tour of some fundamental methods and results of applied mathematics. It is designed for a one-semester course aimed at junior and senior level undergraduate students in the mathematical, physical, and engineering sciences. The prerequisites are an introductory knowledge of calculus, linear algebra, and ordinary differential equations.

The purpose of the book is to provide a context for students to gain a deeper appreciation of mathematics and its connections with other disciplines. It provides a setting in which mathematics can be observed in action, as a tool for exploring meaningful problems in the world around us. Moreover, it illustrates how mathematics is often inspired by real problems, and how mathematical abstraction can lead to physical understanding.

The subjects explored in the book are dimensional analysis and scaling, dynamical systems, perturbation methods, and calculus of variations. These are immense subjects of wide applicability, and a fertile ground for critical thinking and quantitative reasoning, in which every student of applied mathematics should have some experience.

The book originated from a set of lecture notes for the course M 374M at The University of Texas at Austin. It is intended for a course of study focused on concepts and examples. For completeness, proofs of less-standard results are summarized throughout, at the level of the prerequisites, whereas proofs of standard results can be found in the references as noted.

All sections of the book were developed and improved over several years, and have been classroom tested. Over 300 exercises and 180 illustrations are provided to support teaching and learning. The highlights of the book are the case studies and mini-projects, which should be considered as essential for any plan of study. Various exercises provide opportunities for computer simulation and further exploration.

It is expected that students will benefit from this book in a number of ways. They will enhance their understanding of mathematics and gain experience in quantitative

reasoning. They will also gain an appreciation for the intrinsic beauty of mathematical abstraction, and its utility as a guide for critical thinking. And they will acquire tools to explore meaningful problems, and increase their preparedness for research and advanced studies. Students can benefit from this book with minimal prerequisites, before any experience with partial differential equations or real analysis, which increases accessibility for both majors and nonmajors.

I gratefully acknowledge the many authors, mentors, and teachers whose work provided the foundation for the material presented here. My dependence on their work is profound, and too extensive for complete citation.