Preface

This book focuses on the two continuum mechanics models that are commonly encountered by mechanical, aerospace, civil, chemical, bio, and manufacturing engineering students: heat conduction in solids, and stress analysis. Its main purpose is to provide the reader with an insight into the workings of the continuum models and the finite element method by supplying information sufficient to guide intelligent modeling while avoiding tedious formal theorem and proof sequences. The initial boundary value problems are presented with more care than usually found in textbooks at this level, and in particular a proper treatment of the boundary conditions is given much attention. The basis for the formulation of the finite element models is the Galerkin method, as a special case of the method of weighted residuals. This is a very general approach, more broadly applicable than techniques based on variational principles, and it was chosen with the hope of serving the students well throughout their academic careers, including graduate-level courses on numerical solutions of nonlinear initial boundary value problems.

This book is a precipitate of lectures given over the years to Structural Engineering majors in their senior year at the University of California, San Diego. There are two aspects to the book: the first and foremost is a gradual and rational construction of the framework of the finite element models; the second, for the most part parallel, but sometimes subordinate, is the programming of the discussed algorithms in a sound software-engineering methodology. The first aspect of the book is comfortably covered in an undergraduate course in one quarter, but the implementation is only touched upon here and there. One semester would allow ample time for full in-depth treatment of both aspects. On the other hand, presenting this book to graduate students who have been exposed to finite elements before would

allow for the entire book to be studied thoroughly in one quarter, with equal coverage of both aspects.

The students should have a working knowledge of multivariable calculus, differential equations, and linear algebra. The more advanced mathematical tools are reviewed when and where needed. Familiarity with the the basics of solid mechanics will be helpful, but since no important steps are being skipped in the formulations of the models, the book is really practically self-contained in this respect.

An important characteristic of the book is its pragmatic slant: Not only being comprehensible was more important to me than mathematical rigor, but I endeavored to link the book to a software framework that would allow for hands-on, DIY experimenting at all levels of the discussed methods and algorithms. This important resource is the object-oriented Matlab toolbox `SOFEA`, freely available from the author, including all updates and corrections, at

`http://hogwarts.ucsd.edu/~pkrysl/sofea`

The toolbox implements all the models discussed in this book, and is quite useful for research experiments too. Some of the extensions of this toolbox to other problems are also available on the above web site. `SOFEA` does not require any other software other than Matlab itself. It has been tested with Release 14, but even earlier releases are able to run the majority of `SOFEA` classes and example scripts.

I would like to extend my warmest appreciation to those numerous readers of the various drafts of this book, including my students and the anonymous reviewers, who pointed out typos, omissions, and suggested numerous improvements. Thanks!

I hope you have at least as much fun reading the book as I had writing it.

Petr Krysl