Preface

In this text, we provide the readers with the fundamentals of the finite element method for heat and fluid flow problems. Most of the other available texts concentrate either on conduction heat transfer or the fluid flow aspects of heat transfer. We have combined the two to provide a comprehensive text for heat transfer engineers and scientists who would like to pursue a finite element–based heat transfer analysis. This text is suitable for senior undergraduate students, postgraduate students, engineers and scientists.

The first three chapters of the book deal with the essential fundamentals of both the heat conduction and the finite element method. The first chapter deals with the fundamentals of energy balance and the standard derivation of the relevant equations for a heat conduction analysis. Chapter 2 deals with basic discrete systems, which are the fundamentals for the finite element method. The discrete system analysis is supported with a variety of simple heat transfer and fluid flow problems. The third chapter gives a complete account of the finite element method and its relevant history. Several examples and exercises included in Chapter 3 give the reader a full account of the theory and practice associated with the finite element method.

The application of the finite element method to heat conduction problems are discussed in detail in Chapters 4, 5 and 6. The conduction analysis starts with a simple one-dimensional steady state heat conduction in Chapter 4 and is extended to multi-dimensions in Chapter 5. Chapter 6 gives the transient solution procedures for heat conduction problems.

Chapters 7 and 8 deal with heat transfer by convection. In Chapter 7, heat transfer, aided by the movement of a single-phase fluid, is discussed in detail. All the relevant differential equations are derived from first principles. All the three types of convection modes, forced, mixed and natural convection, are discussed in detail. Examples and comparisons are provided to support the accuracy and flexibility of the finite element method. In Chapter 8, convection heat transfer is extended to flow in porous media. Some examples and comparisons provide the readers an opportunity to access the accuracy of the methods employed.

In Chapter 9, we have provided the readers with several examples, both benchmark and application problems of heat transfer and fluid flow. The systematic approach of problem solving is discussed in detail. Finally, Chapter 10 briefly introduces the topic of computer implementation. The readers will be able to download the two-dimensional source codes from the authors' web sites. They will also be able to analyse both two-dimensional heat conduction and heat convection studies on unstructured meshes using the downloaded programs.

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