

Table of Contents

- Preface p. xiii
- Authors p. xvii
- Chapter 1 Introduction p. 1
 - 1.3 Orientation p. 4
 - 1.1 Background p. 1
 - 1.2 Short History p. 2
 - 1.4 Closure p. 6
 - 2.1 Background p. 11
 - 2.3 The "Weak" Statement p. 14
 - 2.4 Closure p. 26
 - References p. 7
- Chapter 2 Method of Weighted Residuals and Galerkin Approximations p. 11
 - 2.2 Classical Solutions p. 12
 - Exercises p. 26
 - References p. 29
- Chapter 3 Finite Element Method in One Dimension p. 31
 - 3.1 Background p. 31
 - 3.2 Shape Functions p. 31
 - 3.2.2 Quadratic Elements p. 35
 - 3.2.3 Cubic Elements p. 37
 - 3.3.1 Galerkin Formulation p. 39
 - 3.3.2 Variable Conduction and Boundary Convection p. 45
 - 3.4 Axisymmetric Heat Conduction p. 55
 - 3.6 Time Dependence p. 77
 - 3.6.1 Spatial Discretization p. 79
 - 3.6.2 Time Discretization p. 81
 - 3.7 Matrix Formulation p. 90
 - 3.8 Solution Methods p. 93
 - 3.9 Closure p. 102
 - Problems p. 103
 - References p. 109
- Chapter 4 Two-Dimensional Triangular Element p. 111
 - 4.1 Background p. 111
 - 4.2 The Mesh p. 112
 - 4.3 Shape Functions p. 116
 - 4.3.1 Linear Shape Functions p. 116
 - 4.3.2 Quadratic Shape Functions p. 122
 - 4.4 Area Coordinates p. 123
 - 4.5 Numerical Integration p. 133
 - 4.6 Conduction in a Triangular Element p. 138
 - 4.7 Steady-State Conduction with Boundary Convection p. 143
 - 4.8 The Axisymmetric Conduction Equation p. 147
 - 4.9 The Quadratic Triangular Element p. 150
 - 4.10 Time-Dependent Diffusion Equation p. 166

- 4.11 Bandwidth p. 176
- 4.12 Mass Lumping p. 181
- 4.13 Closure p. 183
- Exercises p. 183
- References p. 191
- Chapter 5 Two-Dimensional Quadrilateral Element p. 193
- 5.1 Background p. 193
- 5.2 Element Mesh p. 193
- 5.3 Shape Functions p. 195
- 5.3.1 Bilinear Rectangular Element p. 195
- 5.3.2 Quadratic Rectangular Element p. 197
- 3.2.1 Linear Elements p. 32
- 3.3 Steady Conduction Equation p. 39
- 3.5 Natural Coordinate System p. 60
- 5.4 Natural Coordinate System p. 200
- 5.5 Numerical Integration Using Gaussian Quadratures p. 211
- 5.6 Steady-State Conduction Equation p. 215
- 5.7 Steady-State Conduction with Boundary Convection p. 226
- 5.8 The Quadratic Quadrilateral Element p. 239
- 5.9 Time-Dependent Diffusion p. 253
- 5.10 Computer Program Exercises p. 254
- 5.11 Closure p. 257
- Exercises p. 258
- References p. 262
- Chapter 6 Isoparametric Two-Dimensional Elements p. 263
- 6.1 Background p. 263
- 6.2 Natural Coordinate System p. 264
- 6.3 Shape Functions p. 266
- 6.3.1 Bilinear Quadrilateral p. 266
- 6.3.2 Eight-Noded Quadratic Quadrilateral p. 268
- 6.3.3 Linear Triangle p. 269
- 6.3.4 Quadratic Triangle p. 269
- 6.3.5 Directional Cosines p. 270
- 6.4 The Element Matrices p. 273
- 6.5 Inviscid Flow Example p. 277
- 6.6 Closure p. 280
- Exercises p. 281
- References p. 284
- Chapter 7 Three-Dimensional Element p. 285
- 7.1 Background p. 285
- 7.2 Element Mesh p. 285
- 7.3 Shape Functions p. 288
- 7.3.1 Tetrahedron p. 288
- 7.3.2 Hexahedron p. 295
- 7.4 Numerical Integration p. 298
- 7.5 A One-Element Heat Conduction Problem p. 301

- 7.5.1 Tetrahedron p. 303
- 7.5.2 Hexahedron p. 307
- 7.6 Time-Dependent Heat Conduction with Radiation and Convection p. 313
- 7.6.1 Radiation p. 315
- 7.6.2 Shape Factors p. 318
- 7.7 Closure p. 320
- Exercises p. 321
- References p. 326
- Chapter 8 Finite Elements in Solid Mechanics p. 329
- 8.1 Background p. 329
- 8.2 Two-Dimensional Elasticity: Stress/Strain p. 329
- 8.3 Galerkin Approximation p. 333
- 8.4 Potential Energy p. 349
- 8.5 Thermal Stresses p. 356
- 8.6 Three-Dimensional Solid Elements p. 366
- 8.7 Closure p. 369
- Exercises p. 369
- References p. 371
- Chapter 9 Applications to Convective Transport p. 373
- 9.1 Background p. 373
- 9.2 Potential Flow p. 373
- 9.3 Convective Transport p. 391
- 9.4 Nonlinear Convective Transport p. 425
- 9.5 Groundwater Flow p. 430
- 9.6 Lubrication p. 446
- 9.7 Closure p. 452
- Exercises p. 452
- References p. 453
- Chapter 10 Introduction to Viscous Fluid Flow p. 455
- 10.1 Background p. 455
- 10.2 Viscous Incompressible Flow with Heat Transfer p. 456
- 10.3 The Penalty Function Algorithm p. 458
- 10.4 Equal Order: Projection Method p. 461
- 10.5 Application to Free and Forced Convection p. 463
- 10.6 Closure p. 494
- Exercises p. 494
- References p. 495
- Chapter 11 Introduction to Boundary Elements p. 497
- 11.1 Introduction p. 497
- 11.2 One-Dimensional BEM p. 497
- 11.3 Two-Dimensional BEM p. 509
- 11.3.1 Constant Elements p. 515
- 11.3.2 Linear Elements p. 522
- 11.4 Three-Dimensional BEM p. 525
- 11.5 Dual Reciprocity Method p. 526
- 11.6 Closure p. 527

- Exercises p. 528
- References p. 528
- Chapter 12 A Introduction to Meshless Methods p. 531
- 12.1 Background p. 531
- 12.2 History of MemS p. 532
- 12.3 Radial Basis Functions p. 533
- 12.3.1 Global Versus Local RBFs p. 534
- 12.4 The Kansa Approach p. 536
- 12.5 Implementation of the Mem p. 540
- 12.5.1 1-D Formulation p. 540
- 12.5.2 2-D Formulation p. 548
- 12.6 Smooth Particle Hydrodynamics p. 550
- 12.7 Closure p. 550
- Exercises p. 551
- References p. 551
- Appendix A Matrix Algebra p. 553
- Appendix B Units p. 561
- Appendix C Thermophysical Properties of Some Common Materials p. 563
- Appendix D Nomenclature p. 565
- Appendix E Matlab® p. 569
- Appendix F Maple p. 579
- Appendix G Supplemental Routines Used in Maple and Matlab® Examples p. 589
- Index p. 601