

Table of Contents

Preface	xi
0. Direct Solution of Linear Systems	1
0.0 Introduction	1
0.1 General Linear Systems	1
0.2 Systems Requiring No Pivoting	5
0.3 The LU Decomposition	9
0.4 Banded Linear Systems	12
0.5 Sparse Direct Methods	18
0.6 Problems	24
1. Initial Value Ordinary Differential Equations	29
1.0 Introduction	29
1.1 Euler's Method	31
1.2 Truncation Error, Stability and Convergence	32
1.3 Multistep Methods	38
1.4 Adams Multistep Methods	43
1.5 Backward Difference Methods for Stiff Problems	50

1.6 Runge-Kutta Methods	56
1.7 Problems	64
2. The Initial Value Diffusion Problem	67
2.0 Introduction	67
2.1 An Explicit Method	71
2.2 Implicit Methods	76
2.3 A One-Dimensional Example	80
2.4 Multi-Dimensional Problems	83
2.5 A Diffusion-Reaction Example	89
2.6 Problems	93
3. The Initial Value Transport and Wave Problems	97
3.0 Introduction	97
3.1 Explicit Methods for the Transport Problem	103
3.2 The Method of Characteristics	111
3.3 An Explicit Method for the Wave Equation	114
3.4 A Damped Wave Example	120
3.5 Problems	124
4. Boundary Value Problems	129
4.0 Introduction	129
4.1 Finite Difference Methods	133
4.2 A Nonlinear Example	135
4.3 A Singular Example	138
4.4 Shooting Methods	139
4.5 Multi-Dimensional Problems	144
4.6 Successive Over-Relaxation	148
4.7 Successive Over-Relaxation Examples	152
4.8 The Conjugate Gradient Method	164
4.9 Systems of Differential Equations	170
4.10 The Eigenvalue Problem	174
4.11 The Inverse Power Method	178
4.12 Problems	183
5. The Finite Element Method	189
5.0 Introduction	189
5.1 The Galerkin Method for Boundary Value Problems	190

5.2 An Example Using Piecewise Linear Trial Functions	194
5.3 An Example Using Cubic Hermite Trial Functions	199
5.4 A Singular Example	209
5.5 Linear Triangular Elements	216
5.6 Examples Using Triangular Elements	220
5.7 Time-Dependent Problems	227
5.8 A One-Dimensional Example	231
5.9 A Time-Dependent Example Using Triangular Elements	236
5.10 The Eigenvalue Problem	240
5.11 Eigenvalue Examples	242
5.12 Problems	247
Appendix 1	253
Appendix 2	261
References	267
Index	269