

Contents

Preface	vii
Introduction	
Rounding errors and instability	2
2 Linear algebraic equations	8
2.1 Gauss elimination	9
2.2 Matrix decomposition methods	16
2.3 Iterative methods	27
3 Non-linear algebraic equations	43
3.1 Bracketing methods	43
3.2 Fixed point iteration	50
3.3 Newton's method	57
3.4 Systems of non-linear equations	64
4 Eigenvalues and eigenvectors	71
4.1 The power method	72
4.2 Deflation	80
4.3 Jacobi's method	88
4.4 Sturm sequence iteration	97
4.5 Givens' and Householder's methods	102
4.6 The <i>LR</i> and <i>QR</i> methods	110
4.7 Hessenberg form	119
5 Methods of approximation theory	129
5.1 Polynomial interpolation: Lagrange form	130
5.2 Polynomial interpolation: divided difference form	138
5.3 Polynomial interpolation: finite difference form	145
5.4 Hermite interpolation	152
5.5 Cubic spline interpolation	159
5.6 Least squares approximation to discrete data	172
5.7 Least squares approximation to continuous functions	180
6 Numerical differentiation and integration	190
6.1 Numerical differentiation	191
6.2 Numerical integration: Newton–Cotes formulas	199

vi *Contents*

6.3	Quadrature rules in composite form	209
6.4	Romberg's method	215
6.5	Simpson's adaptive quadrature	221
6.6	Gaussian quadrature	227
7	Ordinary differential equations: initial value problems	233
7.1	Derivation of linear multistep methods	233
7.2	Analysis of linear multistep methods	244
7.3	Runge–Kutta methods	254
7.4	Systems and higher order equations	258
8	Ordinary differential equations: boundary value problems	265
8.1	The finite difference method	266
8.2	The shooting method	271
	Appendix	277
	References	279
	Solutions to exercises	281
	Index	323