Contents

Preface ix

1 INTERPOLATION and CURVE FITTING 1
1.1 Lagrange and Lagrange-Like Interpolation 2
1.2 Spline Interpolation 7
1.3 Interpolation by Pade Approximants 12
1.4 Operator Interpolation for Equally Spaced Data 13
1.5 Curve Fitting by the Method of Least Squares 18
Problems 26

2 ZEROS of a FUNCTION 31
2.1 Roots of a Cubic Polynomial 31
2.2 Roots of a Quartic/Biquadratic Polynomial 43
2.3 Regula Falsi and Newton–Raphson Methods 47
2.4 Zeros by Interpolation for Discrete Data 51
2.5 Roots of a Polynomial by Root Squaring Methods 56
Problems 71

3 SERIES 73
3.1 Definitions and Convergence 73
3.2 Summing a Series 78
3.3 Approximating the Sum of a Convergent Series 89
3.4 Fourier Series 96
Problems 102

4 INTEGRATION 105
4.1 Expanding the Integrand in a Series 105
4.2 Euler–MacLaurin Approximation 106
4.3 Newton-Cotes Quadratures 112
4.4 Gaussian Quadratures 123
4.5 Integral of a Function with Singularities 145

4.6 Monte Carlo Integration 154
4.7 Evaluating Integrals Using the Gamma and Beta Functions 157
4.8 Integration Using Heaviside Operators 162
Problems 165

5 DETERMINANTS AND MATRICES 169
5.1 Evaluation of a Determinant 169
5.2 Matrices 182
Problems 235

6 ORDINARY FIRST ORDER DIFFERENTIAL EQUATIONS 237
6.1 Taylor Series Approximation 238
6.2 Picard Method 243
6.3 Runge–Kutta Method 245
6.4 Finite Difference Methods 249
6.5 Predictor–Corrector Methods 254
Problems 266

7 ORDINARY SECOND ORDER DIFFERENTIAL EQUATIONS 269
7.1 Initial and Boundary Conditions 269
7.2 Taylor Series Approximations for Equations Subject to Initial Conditions 271
7.3 Runge–Kutta Approximations for Equations Subject to Initial Conditions 273
7.4 Finite Difference Approximate Solutions for Equations Subject to Initial Conditions 277
7.5 Finite Difference Approximations for Equations Subject to Boundary Conditions 283
7.6 Shooting Method for Equations Subject to Dirichlet Boundary Conditions 297
7.7 Frobenius Approximations 301
Problems 312

8 PARTIAL DIFFERENTIAL EQUATIONS 315
8.1 Initial and Boundary Conditions 316
8.2 Taylor Series Approximations 318
8.3 Runge–Kutta Approximations 327
8.4 Finite Difference Methods 333
Problems 377

9 LINEAR INTEGRAL EQUATIONS IN ONE VARIABLE 383
9.1 Fredholm Equations of the First Kind with Non-singular Kernel 383
9.2 Fredholm Equations of the Second Kind with Non-singular Kernel 392
9.3 Eigensolutions of Fredholm Equations of the Second Kind with Non-singular Kernel 407

9.4 Volterra Equations with Non-singular Kernel 414
9.5 Fredholm Equations with Weakly Singular Kernel 421
9.6 Fredholm Equations with Kernels Containing a Pole Singularity 434
Problems 442

Appendix 1 447

Appendix 2 451

Appendix 3 455

Appendix 4 469

Appendix 5 475

References 479

Index 481