Solutions Manual to Accompany AN INTRODUCTION TO NUMERICAL METHODS AND ANALYSIS

Revised Edition

JAMES F. EPPERSON



CONTENTS

Pre	face		ix
1	Intro	ductory Concepts and Calculus Review	1
	1.1	Basic Tools of Calculus	1
	1.2	Error, Approximate Equality, and Asymptotic Order Notation	12
	1.3	A Primer on Computer Arithmetic	15
	1.4	A Word on Computer Languages and Software	19
	1.5	Simple Approximations	19
	1.6	Application: Approximating the Natural Logarithm	21
2	A Survey of Simple Methods and Tools		25
	2.1	Horner's Rule and Nested Multiplication	25
	2.2	Difference Approximations to the Derivative	28
	2.3	Application: Euler's Method for Initial Value Problems	37
	2.4	Linear Interpolation	41
	2.5	Application — The Trapezoid Rule	46
	2.6	Solution of Tridiagonal Linear Systems	54
	2.7	Application: Simple Two-Point Boundary Value Problems	58

VI CONTENTS

3	Root	-Finding	63
	3.1	The Bisection Method	63
	3.2	Newton's Method: Derivation and Examples	68
	3.3	How to Stop Newton's Method	72
	3.4	Application: Division Using Newton's Method	75
	3.5	The Newton Error Formula	79
	3.6	Newton's Method: Theory and Convergence	82
	3.7	Application: Computation of the Square Root	86
	3.8	The Secant Method: Derivation and Examples	90
	3.9	Fixed Point Iteration	95
	3.10	Special Topics in Root-finding Methods	98
4	⊮ Inter	polation and Approximation	111
	4.1	Lagrange Interpolation	111
	4.2	Newton Interpolation and Divided Differences	114
	4.3	Interpolation Error	126
	4.4	Application: Muller's Method and Inverse Quadratic	
		Interpolation	132
	4.5	Application: More Approximations to the Derivative	135
	4.6	Hermite Interpolation	136
	4.7	Piecewise Polynomial Interpolation	139
	4.8	An Introduction to Splines	142
	4.9	Application: Solution of Boundary Value Problems	149
	4.10	Least Squares Concepts in Approximation	151
	4.11	Advanced Topics in Interpolation Error	158
5	Num	erical Integration	163
	5.1	A Review of the Definite Integral	163
	5.2	Improving the Trapezoid Rule	165
	5.3	Simpson's Rule and Degree of Precision	169
	5.4	The Midpoint Rule	178
	5.5	Application: Stirling's Formula	181
	5.6	Gaussian Quadrature	, 183
-	5.7	Extrapolation Methods	189
	5.8	Special Topics in Numerical Integration	193
6	Num	erical Methods for Ordinary Differential Equations	201

		CONTENTS	vii
	6.1	The Initial Value Problem — Background	201
	6.2	Euler's Method	203
	6.3	Analysis of Euler's Method	206
	6.4	Variants of Euler's Method	207
	6.5	Single Step Methods — Runge-Kutta	215
	6.6	Multi-step Methods	218
	6.7	Stability Issues	223
	6.8	Application to Systems of Equations	225
	6.9	Adaptive Solvers	229
	6.10	Boundary Value Problems	231
7	Numerical Methods for the Solution of Systems of Equations		
	7.1	Linear Algebra Review	235
	7.2	Linear Systems and Gaussian Elimination	236
	7.3	Operation Counts	241
	7.4	The LU Factorization	243
	7.5	Perturbation, Conditioning and Stability	247
	7.6	SPD Matrices and the Cholesky Decomposition	254
	7.7	Iterative Methods for Linear Systems - A Brief Survey	256
	7.8	Nonlinear Systems: Newton's Method and Related Ideas	258
	7.9	Application: Numerical Solution of Nonlinear BVP's	260
8	Approximate Solution of the Algebraic Eigenvalue Problem		
	8.1	Eigenvalue Review	263
	8.2	Reduction to Hessenberg Form	266
	8.3	Power Methods	266
	8.4	An Overview of the QR Iteration	270
9	Finite Difference Methods for PDE's		
	9.1	Difference Methods for the Diffusion Equation	273
	9.2	Difference Methods for Poisson Equations	278