CONTENTS

Preface	v
Chapter 1. Approximation	1
1.1 Introduction	1
1.2 Discrete Functions	1
1.3 Interpolation	3
1.4 Lagrange Interpolation Formulas	5
1.5 General Theory	9
1.6 Least-Squares Interpolation	12
1.7 Selected Theory for Least-Squares Interpolation	15
1.8 Remarks	18
Exercises	18
CHAPTER 2. APPROXIMATE INTEGRATION AND DIFFERENTIATION	22
2.1 Introduction	22
2.2 Trapezoidal Rule	2.3
2.3 Theory for the Trapezoidal Rule	25
2.4 Simpson's Rule	29
2.5 Theory for Simpson's Rule	30
2.6 Approximate Integration by Least Squares	32
2.7 Remarks on Approximate Integration	32
2.8 Approximate Differentiation	34
Exercises	40
CHAPTER 3. ALGEBRAIC AND TRANSCENDENTAL SYSTEMS	42
3.1 Introduction	42
3.2 Matrices and Linear Systems	42
3.3 Tridiagonal Linear Systems	43

viii CONTENTS

3.4 Direct Solution of Tridiagonal Systems	47
3.5 Iterative Solution of Linear and Nonlinear Systems	53
3.6 Remarks	60
Exercises	60
CHAPTER 4. SECOND-ORDER DIFFERENTIAL AND DIFFERENCE EQUATIONS	65
4.1 Introduction	65
4.2 Linear Differential Equations	67
4.3 Linear Differential Equations with Constant Coefficients	69
4.4 Linear Differential Equations with Nonconstant Coefficients	72
4.5 Initial- and Boundary-Value Problems	79
4.6 Difference Equations	81
Exercises	85
CHAPTER 5. APPROXIMATE SOLUTION OF BOUNDARY-VALUE	
PROBLEMS FOR DIFFERENTIAL EQUATIONS	88
	88
5.1 Introduction5.2 Approximate Solution of Linear Boundary-Value Problems	88
5.2 Approximate Solution of Linear Boundary-Value 5.3 Approximate Solution of Nonlinear Boundary-Value	00
Problems	93
5.4 Convergence	95
5.5 Remarks	99
Exercises	99
CHAPTER 6. APPROXIMATE SOLUTION OF INITIAL-VALUE PROBLEMS	101
FOR ORDINARY DIFFERENTIAL EQUATIONS	101
6.1 Introduction	101
6.2 First-Order Differential Equations	102
6.3 First-Order Difference Equations	104
6.4 Euler's Method	105
6.5 Convergence	107
6.6 A Runge–Kutta Method	111
6.7 Higher-Order Runge–Kutta Formulas	113
6.8 Approximate Solution of Initial-Value Problems for	114
Second-Order Differential Equations	114
6.9 Nonlinear Pendulum	116 119
6.10 Instability	123
6.11 Remarks	123
Exercises	1 4.

CONTENTS	1X

CHAPTER	7. DISCRETE MODEL THEORY	126
7.1	Introduction	126
7.2	Implications of Constraints on Measurement	126
	Special Discrete Functions	127
	Particles, Time, and Motion	129
7.5	Velocity and Acceleration	130
	Law of Motion	133
7.7	Damped Motion in a Nonlinear Force Field	133
	Conservation of Energy	136
7.9	Momentum	139
7.10	Angular Velocity and Acceleration	140
	Remark	144
	Exercises	144
CHAPTER	8. Interval Arithmetic	147
8.1 I	ntroduction	147
8.2 I	nterval Arithmetic	148
8.3 (General Application of Interval Arithmetic	158
	Application to Difference Equations	159
	Remarks	162
I	Exercises	163
REFERENC	EES AND SOURCES FOR FURTHER READING	167
Answers	TO SELECTED EXERCISES	173
Index		179