

Contents

1	Introduction	1
1.1	A Brief History	1
1.2	Book Layout	5
	References.	6
2	Nonlinear Discrete Systems	11
2.1	Definitions	11
2.2	Fixed Points and Stability	13
2.3	Stability Switching Theory	24
2.4	Bifurcation Theory	41
	References.	50
3	Discretization of Continuous Systems	51
3.1	Continuous Systems	51
3.2	Basic Discretization	54
3.2.1	Forward Euler's Method	55
3.2.2	Backward Euler's Method	59
3.2.3	Trapezoidal Rule Discretization	63
3.2.4	Midpoint Method	68
3.3	Introduction to Runge–Kutta Methods	72
3.3.1	Taylor Series Method	73
3.3.2	Runge–Kutta Method of Order 2	78
3.4	Explicit Runge–Kutta Methods	81
3.4.1	Runge–Kutta Method of Order 3	89
3.4.2	Runge–Kutta Method of Order 4	96
3.5	Implicit Runge–Kutta Methods	101
3.5.1	Polynomial Interpolation	102
3.5.2	Implicit Runge–Kutta Methods	105
3.5.3	Gauss Method	111
3.5.4	Radau Method	114
3.5.5	Lobatto Method	118

3.5.6	Diagonally Implicit RK Methods	121
3.5.7	Stability of Implicit Runge–Kutta Methods.	124
3.6	Multi-step Methods	128
3.6.1	Adams–Bashforth Methods	128
3.6.2	Adams–Moulton Methods	137
3.6.3	Explicit Adams Methods	144
3.6.4	Implicit Adams Methods	146
3.6.5	General Forms	150
3.7	Generalized Implicit Multi-step Methods	152
	References.	157
4	Implicit Mapping Dynamics	159
4.1	Single-Step Implicit Maps	159
4.2	Discrete Systems with Multiple Maps	170
4.3	Complete Dynamics of a Henon Map System.	174
4.4	Multi-step Implicit Maps	181
	References.	197
5	Periodic Flows in Continuous Systems	199
5.1	Continuous Nonlinear Systems	199
5.2	Continuous Time-Delay Systems	218
5.2.1	Interpolated Time-Delay Nodes	218
5.2.2	Integrated Time-Delay Nodes	242
5.3	Discrete Fourier Series	268
	References.	279
6	Periodic Motions to Chaos in Duffing Oscillator.	281
6.1	Period-1 Motions	281
6.2	Period-m Motions	285
6.3	Bifurcation Trees of Periodic Motions	287
6.4	Frequency–Amplitude Characteristics	294
6.4.1	Period-1 Motions to Chaos.	296
6.4.2	Period-3 Motions	299
6.5	Numerical Simulations.	300
	Reference	307
	Index	309