

Contents

1	<i>System Concepts and Descriptions</i>	1
	Intuitive Notions	1
	Mathematical Descriptions	6
	Notes and References	21
2	<i>Basic Questions and Perspectives on System Theory</i>	23
	Controlled versus Free Dynamics	23
	Identification	25
	Constraints	27
	Stochastic Effects	30
	Optimization	31
	Global Perspectives	32
	Connectivity and Graphs	35
	Connectivity and Simplicial Complexes	37
	Complexity	40
	Stability	45
	Catastrophes and Resilience	49
	Notes and References	53
3	<i>Connectivity</i>	57
	Complexes and Connections	58
	Eccentricity	60
	Holes and Obstructions	61
	Betti Numbers and Torsion	66
	p -Holes	66
	Cochains and Coboundaries	68

	Predator–Prey Relations: A Homological Example	70
	Hierarchical Systems and Covers	74
	Applications of q -Connectivity to Chess and Shakespearean Drama	76
	Algebraic Connectivity	81
	Linear Systems	82
	Nonlinear Problems	88
	Semigroups and Wreath Products	88
	Krohn–Rhodes Decomposition Theorem	90
	Decomposition of Analytic Systems	92
	Notes and References	93
4	<i>Complexity</i>	97
	Static Complexity	98
	Dynamic Complexity	102
	Computational Complexity	105
	Axioms of System Complexity	106
	Complexity of Finite-State Machines	108
	Evolution Complexity and Evolving Structures	110
	Choice Processes and Complexity	113
	Design versus Control Complexity	115
	A Program for Practical Applications of Complexity	116
	Polyhedral Dynamics and Complexity	116
	Algebraic System Theory and Complexity	117
	Nonlinear, Finite-Dimensional Processes	119
	Complexity and Information Theory	120
	Notes and References	122
5	<i>Stability, Catastrophes, and Resilience</i>	126
	External Descriptions	127
	Internal Descriptions	127
	Structural Stability	129
	Connective Stability and Resilience	130
	Graphs and Pulse Processes	131
	Input–Output Stability	133
	Internal Models and Stability	135
	Connective Stability	141
	Hopf Bifurcations	144
	Structurally Stable Dynamics	147
	Catastrophe Theory	151
	Some Catastrophe-Theoretic Examples	156
	The Cusp Catastrophe and the Logistic Equation	162
	Pulse and Value Stability	163

Resilience of Dynamical Processes	166
Resilience and Catastrophes	169
Morse–Smale Systems and Resilience	173
Stability, Control, and Feedback Decisions	181
Lyapunov Stability and Pole-Shifting	183
Bifurcation Control	187
Controlled Resilience	189
Observations	193
Notes and References	193
Index	201