



Contents

Nº 2718

Preface xi

chapter 1 Introduction 1

- 1.1 Motivation and History 2
- 1.2 Objectives 3
 - The Analytical-Algorithmic Dimension 4
 - The Continuous-Discrete Dimension 7
 - The Linear-Nonlinear Dimension 8
 - Summary of Objectives and Methodology 10

chapter 2 Systems and the State Model 11

- 2.1 Definition and Analysis of Systems 12
- 2.2 Synthesis 19
- 2.3 Memory and Memoryless Systems 20
 - Memoryless Systems and Relations 29
- 2.4 The State Model 32
 - Generalization of the State Model 35
 - Rules for a System That Can Be Put in State Model Form 37
 - Concluding Remarks 39
- Problems* 40

chapter 3 Continuous Memoryless Systems 43

- 3.1 Introduction 44
- 3.2 Definitions 44
- 3.3 Modeling Physical Devices with Function Blocks 49
- 3.4 Explicit and Implicit Systems 50

3.5	Formulation and Solution of System Equations	53
	Explicit Systems	53
	Implicit Systems	56
3.6	Linearity	60
3.7	Equivalence and Approximation	65
	Approximation	68
	Problems	72
chapter 4	Resistive Networks	77
4.1	Introduction	78
4.2	Network Structures	78
4.3	The Constraints	80
	Overview	80
	The Network Variables	80
	Reference Directions	83
	Topological Constraints (KCL and KVL)	84
	Element Constraints	89
4.4	Formulation and Solution of Resistive Network Equations	98
	Node Voltages	98
	General Node-voltage Equations	100
	Linear Node-voltage Equations: Current Sources	104
	Linear Node-voltage Equations: Voltage Sources	106
	Linear Node-voltage Equations: Dependent Sources	110
	Nonlinear Node-voltage Equations	112
	Solution of Node-voltage Equations: Existence and Uniqueness	115
4.5	Linearity	116
	Linearity of Node-voltage Equations	116
	Superposition	118
	Homogeneity	121
4.6	Equivalence	124
	General Considerations	124
	Series and Parallel Resistors	125
	Nonlinear Network Equivalences	131
	Thévenin and Norton Equivalent Circuits	133
4.7	Block Diagram Systems from Resistive Networks	139
	General Considerations	139
	Realization of Scalers	139
	Realization of Summers	141
	Resistor-Diode Networks and the Threshold Block	142
	Realization of Monotonically Increasing Piecewise-linear Functions	145
	Problems	146
chapter 5	Iteration	157
5.1	Introduction	158
5.2	Iteration	158

5.3	Iterative Solution of $x = f(x)$: Picard's Algorithm	163
	Existence of Solutions	164
	Uniqueness of Solution	165
	Convergence of the Algorithm $x_{k+1} = f(x_k)$	169
	Speed of Convergence	171
	Graphical Interpretation of Contraction	173
	An Old Example in a New Light	175
	Recapitulation	177
5.4	Iterative Solution of $F(x) = 0$: Newton's Method	177
	Newton's Method from Picard's Method	178
	Newton's Method	179
	Newton's Method from Taylor Series Expansion	180
	Convergence of Newton's Method	182
	Speed of Convergence	183
5.5	Solution of $f(x) = x$: Higher-order Convergence	186
5.6	Concluding Remarks	187
	<i>Problems</i>	188

chapter 6 Discrete Memoryless Systems 199

6.1	Introduction	200
6.2	Logic Circuits	202
6.3	Logic Gates	203
6.4	Boolean Algebra	209
6.5	Boolean Functions and Expressions	213
6.6	Combinational Logic and Boolean Functions	216
6.7	Minimization of Boolean Functions	223
6.8	Examples, Functional Completeness, and Don't Cares	232
	<i>Problems</i>	239

chapter 7 Dynamic Systems and Networks: State Analysis 247

7.1	Introduction	248
7.2	First-order Block Diagram Systems	249
7.3	Capacitors and Inductors: The Building Blocks of Dynamic Networks	255
	Mathematical Characterization	255
	Physical Aspects of Capacitors and Inductors	259
	Power and Energy in Network Elements	261
	Electrical Quantities and Their Interrelationship	263
7.4	First-order Networks	265
	Formulation of the State and Output Equations	266
	Making an Integrator out of Network Elements	270
7.5	Solution of a Simple First-order Ordinary Differential Equation	273
	Walking through a Nonlinear First-order Differential Equation	275
7.6	Solution of First-order Differential Equations	278
	The Unforced Case	279

	The Forced Case	280
	Constant Excitation	283
	Exponential Excitation	284
	Sinusoidal Excitation	285
	Nonlinear First-order Differential Equations	285
7.7	Step and Pulse Response of Linear First-order Networks and Systems	287
	The RC Network: Step Response	287
	The RC Network: Narrow-pulse Response	292
	Linearity and Superposition	294
	Justification of Theorem 7.7-1	297
	A First-order Opamp System	299
	A Diode-Capacitor Network	301
7.8	Second-order Systems and Networks	303
	Formulating Two Simultaneous Differential Equations	303
	Solution of Two Simple Second-order Systems	307
	Problems	312

chapter 8 Dynamic Systems and Networks: Input-Output Analysis 323

8.1	Introduction	324
8.2	Examples of Input-Output Representations	325
	Generalization	327
8.3	Singularity Functions	328
8.4	Solution of Linear Differential Equations	332
	Double Roots	337
	Excitation at a Natural Frequency	339
	Higher-order Equations	340
	Sudden Excitations	341
	Forcing-function and Solution Derivatives	344
	Superposition	346
	Generalization	348
8.5	Steady-state Solution and the System Function	350
8.6	Impedance: System Functions for Networks	353
	An RLC Network Example	353
	General Considerations	355
	Use of Element Impedances	357
8.7	The s -Plane: Graphical Evaluation of $H(s)$	360
8.8	Sinusoidal Steady-state Analysis	364
	General Considerations	364
	Complex and Real Excitations	365
	Rotating Vectors	368
	Evaluation of Frequency Response	369
8.9	Impedance and Natural Frequencies	375
	Problems	378

chapter 9	Computational Solution of Differential Equations	389
9.1	Introduction	390
9.2	Computation of Definite Integrals	390
	The Interpolating Polynomial	392
	Specialization to Integration Methods	395
	Integration Error	398
9.3	Computational Solution of Ordinary Differential Equations	402
	Classification of Methods	403
	Open Methods	405
	Closed Methods	407
9.4	Errors of Open and Closed Methods	410
	<i>Problems</i>	412
chapter 10	Finite-state Machines	417
10.1	Introduction	418
10.2	Discrete Memory Elements	418
	Combination Lock	420
10.3	Definition of a Finite-state Machine	423
	The Combination Lock as a Finite-state Machine—State Tables and Transition Graphs	424
10.4	Input-Output Behavior and Characterization	425
10.5	Design of Finite-state Machines	427
	State Equivalence	430
	Partially Specified Machines	434
	Properties of Reduced Machines	435
10.6	Sequential Circuits	435
	Synthesis of Sequential Circuits	442
	Realizations Using J-K Flip-Flops	446
10.7	Limitations of Finite-state Machines	452
	<i>Problems</i>	453
chapter 11	Ideal Delay and Convolution	461
11.1	Introduction: A Linear Transmission System Utilizing Nonlinearity and Ideal Delay	462
11.2	Ideal Delay and Integration	465
11.3	The State Model with Memory in the Form of Ideal Delay	467
11.4	The Basic Linear Model: Cascaded Delay with Parallel Feedback	468
11.5	The Uncoupled Linear Model: Parallel Delay with Local Feedback	471
11.6	Pulse Response of the Primitive First-order Model	474
11.7	Illustrative Examples of Transformation from Cascade to Parallel Delay	475

- 11.8 The Finite Nonfeedback Model and Its Response to a Unit Pulse 479
- 11.9 The Matched Filter 481
- 11.10 The Superposition Integral 484
- 11.11 The Convolution Operation 485
- 11.12 Linear-system Equivalences Representing the Basic Properties of Convolution 487
- 11.13 Convolutions Involving Delay, Differentiation, and Integration 489
- 11.14 Comparison of Integration and Delay as System Memory Elements 492
- 11.15 The System Function 494
- Problems 496

Appendix A Complex Numbers and Exponentials 501

Index 507