

Contents

SECTION I Mathematics

Section Editor:	<i>Y. F. Huang</i>	1
1	Linear Operators and Matrices <i>Cheryl B. Schrader and Michael K. Sain</i>	3
2	Bilinear Operators and Matrices <i>Michael K. Sain and Cheryl B. Schrader</i>	23
3	The Laplace Transform <i>John R. Deller, Jr.</i>	42
4	Fourier Series, Fourier Transforms and the DFT <i>W. Kenneth Jenkins</i>	88
5	<i>z</i> -Transform <i>Jelena Kovačević</i>	116
6	Wavelet Transforms <i>P. P. Vaidyanathan and Igor Djokovic</i>	134
7	Graph Theory <i>Krishnaiyan Thulasiraman</i>	220
8	Signal Flow Graphs <i>Krishnaiyan Thulasiraman</i>	248

SECTION II Circuit Components and Their Characterization

Section Editor:	<i>John Choma, Jr.</i>	261
9	Passive Circuit Elements	
9.1	Resistor <i>Stanisław Nowak</i>	263
9.2	Capacitor <i>Stanisław Nowak</i>	285
9.3	Inductor <i>Tomasz W. Postupolski</i>	302
9.4	Transformer <i>Gordon E. Carlson</i>	326
9.5	Semiconductor Diode <i>B. M. Wilamowski</i>	333
10	Controlled Circuit Elements	
10.1	Controlled Sources <i>Edwin W. Greeneich</i>	345
10.2	Signal Converters <i>James F. Delansky</i>	351
11	Operational Amplifiers	
11.1	The Ideal Operational Amplifier <i>David G. Nairn</i>	360
11.2	The Nonideal Operational Amplifier <i>David G. Nairn</i>	371
11.3	Frequency- and Time-Domain Considerations <i>Sergio Franco</i>	383

SECTION III General Circuit Theory

Section Editor:	<i>John Choma, Jr.</i>	401
12	Fundamental Circuit Concepts <i>John Choma, Jr.</i>	403
13	Network Laws and Theorems	
13.1	Kirchhoff's Voltage and Current Laws <i>Ray R. Chen and Artice M. Davis</i>	418
13.2	Network Theorems <i>Marwan A. Simaan</i>	457
14	Analysis in the Time Domain <i>Robert W. Newcomb</i>	475
15	Analysis in the Frequency Domain	
15.1	Network Functions <i>Jiri Vlach</i>	493
15.2	Advanced Network Analysis Concepts <i>John Choma, Jr.</i>	503
15.3	Linear Two-Port Networks <i>John Choma, Jr. and Wai-Kai Chen</i>	532
16	Theory of Two-Dimensional Hurwitz Polynomials <i>Hari C. Reddy</i>	582

SECTION IV Linear Circuit Analysis

Section Editor:	<i>Lawrence P. Huelsman</i>	597
17	Terminal and Port Representations <i>James A. Svoboda</i>	599
18	Signal Flow Graphs in Filter Analysis and Synthesis <i>Pen-Min Lin</i>	619
19	Tableau and Modified Nodal Formulations <i>Jiri Vlach</i>	639
20	Frequency Domain Methods <i>Peter Aronhime</i>	660
21	Symbolic Analysis <i>Marwan M. Hassoun</i>	730
22	Using Nullors to Analyze Linear Networks <i>James A. Svoboda</i>	751
23	State-Variable Techniques <i>K. S. Chao</i>	776

SECTION V Feedback Circuits

Section Editor:	<i>Wai-Kai Chen</i>	799
24	Feedback Amplifier Theory <i>John Choma, Jr.</i>	801
25	Feedback Amplifier Configurations <i>John Choma, Jr.</i>	820
26	General Feedback Theory <i>Wai-Kai Chen</i>	851
27	The Network Functions and Feedback <i>Wai-Kai Chen</i>	865
28	Measurement of Return Difference <i>Wai-Kai Chen</i>	875
29	Multiple-Loop Feedback Amplifiers <i>Wai-Kai Chen</i>	881

SECTION VI Nonlinear Circuits

Section Editor:	<i>Leon O. Chua</i>	901
-----------------	---------------------	-----

30	Circuit Elements, Modeling, and Equation Formulation	<i>Josef A. Nossek</i>	903
31	Qualitative Analysis	<i>Martin Hasler</i>	914
32	Synthesis and Design of Nonlinear Circuits	<i>A. Rodríguez-Vázquez, M. Delgado-Restituto, J. L. Huertas, and F. Vidal</i>	935
33	Representation, Approximation, and Identification	<i>Guanrong Chen</i>	973

SECTION VII Nonlinear Circuits II

Section Editor:	<i>Leon O. Chua</i>	1009	
34	Transformation and Equivalence	<i>Wolfgang Mathis</i>	1011
35	Piecewise-Linear Circuits and Piecewise-Linear Analysis	<i>J. Vandewalle and L. Vandenberghe</i>	1034
36	Simulation	<i>Erik Lindberg</i>	1058
37	Cellular Neural Networks	<i>Tamás Roska</i>	1072
38	Bifurcation and Chaos	<i>Michael Peter Kennedy</i>	1089

SECTION VIII Distributed Circuits

Section Editor:	<i>T. K. Ishii</i>	1165	
39	Transmission Lines	<i>T. K. Ishii</i>	1167
40	Multiconductor Transmission Lines	<i>Daniël De Zutter and Luc Martens</i>	1185
41	Time and Frequency Domain Responses	<i>Luc Martens and Daniël De Zutter</i>	1193
42	Distributed RC Networks	<i>Vladimir Székely</i>	1203
43	Synthesis of Distributed Circuits	<i>T. K. Ishii</i>	1222

SECTION IX Stability Analysis

Section Editor:	<i>Ruey-wen Liu</i>	1245	
44	Stability Tests for Polynomials	<i>Peter Bauer</i>	1247
45	Root Locus	<i>Peter Bauer</i>	1268
46	The Nyquist Criterion	<i>Charles E. Rohrs</i>	1278
47	Robustness—Stability and Performance Under Modeling Uncertainty	<i>Charles E. Rohrs</i>	1298
48	Controller Design Using Nyquist-Bode Techniques	<i>Charles E. Rohrs</i>	1317
49	Stability Robustness	<i>Wu-Sheng Lu</i>	1344
50	Robust Stability of Circuits with Multiple Uncertain Parameters	<i>Li Qiu</i>	1363

SECTION X Computer-Aided Design and Optimization

Section Editor:	<i>S. M. Kang</i>	1373	
51	Modeling of Circuit Performances	<i>S. M. Kang and A. Dharchoudhury</i>	1375
52	Symbolic Analysis Methods	<i>Marwan M. Hassoun</i>	1392
53	Numerical Analysis Methods	<i>Andrew T. Yang</i>	1412
54	Design by Optimization	<i>Sachin S. Sapatnekar</i>	1428
55	Statistical Design Optimization	<i>Maciej A. Styblinski</i>	1453

SECTION XI Analog Integrated Circuits

Section Editor:	<i>John Choma, Jr.</i>	1489	
56	Monolithic Device Models		
56.1	Bipolar Junction Transistor	<i>B. M. Wilamowski</i>	1491
56.2	MOSFET Technology Devices	<i>John Choma, Jr.</i>	1509
56.3	JFET Technology Transistors	<i>Stephen I. Long</i>	1557
56.4	Passive Components	<i>Nhat M. Nguyen</i>	1571
56.5	Chip Parasitics in Analog Integrated Circuits	<i>Martin A. Brooke</i>	1605
57	Analog Circuit Cells		
57.1	Bipolar Biasing Circuits	<i>K. V. Noren</i>	1619
57.2	Canonic Cells of Linear Bipolar Technology	<i>John Choma, Jr., and J. Trujillo</i>	1628
57.3	MOSFET Biasing Circuits	<i>D. G. Haigh, B. Redman-White, and R. Akbari-Dilmaghani</i>	1676
57.4	Canonical Cells of MOSFET Technology	<i>M. Ismail, S.-C. Huang, C.-C. Hung, and T. Saether</i>	1699
58	High-Performance Analog Circuits		
58.1	Broadband Bipolar Networks	<i>Chris Toumazou, Alison Payne, John Lidgey</i>	1722
58.2	Bipolar Noise	<i>B. M. Wilamowski</i>	1774

SECTION XII Digital and Analog VLSI

Section Editor:	<i>John Choma, Jr.</i>	1781	
59	Physical Design Automation	<i>Naveed Sherwani</i>	1783
60	Design Automation Technology	<i>Allen M. Dewey</i>	1809
61	Computer-Aided Analysis		
61.1	Analog Circuit Simulation	<i>J. Gregory Rollins</i>	1841
61.2	Parameter Extraction for Analog Circuit Simulation	<i>Peter Bendix</i>	1861
62	Digital Circuits		
62.1	MOS Logic Circuits	<i>John P. Uyemura</i>	1888
62.2	Transmission Gates	<i>Bing J. Sheu and Robert C. Chang</i>	1903

63	Digital Systems	
63.1	Programmable Logic Devices <i>F. Gail Gray</i>	1922
63.2	Clocking Schemes <i>Wayne D. Grover</i>	1951
63.3	MOS Storage Circuits <i>Josephine C. Chang and Bing J. Sheu</i>	1993
63.4	Microprocessor-Based Design <i>Roland Priemer</i>	2005
63.5	Systolic Arrays <i>Kung Yao and Flavio Lorenzelli</i>	2034
64	Data Converters	
64.1	Digital-to-Analog Converters <i>Bang-Sup Song</i>	2072
64.2	Analog-to-Digital Converters <i>Ramesh Harjani</i>	2098

SECTION XIII Filter Characteristics

	Section Editor: <i>Lawrence P. Huelsman</i>	2129
65	General Characteristics of Filters <i>Andreas Antoniou</i>	2131
66	Approximation <i>Artice M. Davis</i>	2161
67	Frequency Transformations <i>Jaime Ramirez-Angulo</i>	2192
68	Sensitivity and Selectivity <i>Igor M. Filanovsky</i>	2205

SECTION XIV Passive Filters

	Section Editor: <i>Wai-Kai Chen</i>	2239
69	Passive Immittances and Positive-Real Functions <i>Wai-Kai Chen</i>	2241
70	Passive Cascade Synthesis <i>Wai-Kai Chen</i>	2249
71	Synthesis of LCM and RC One-Port Networks <i>Wai-Kai Chen</i>	2265
72	Two-Port Synthesis by Ladder Development <i>Wai-Kai Chen</i>	2276
73	Design of Resistively Terminated Networks <i>Wai-Kai Chen</i>	2292
74	Design of Broadband Matching Networks <i>Wai-Kai Chen</i>	2304

SECTION XV Active Filters

	Section Editor: <i>Lawrence P. Huelsman</i>	2337
75	Low-Gain Active Filters <i>Phillip E. Allen, Benjamin J. Blalock, and Stephen W. Milam</i>	2339
76	Single-Amplifier Multiple-Feedback Filters <i>F. William Stephenson</i>	2372
77	Multiple-Amplifier Biquads <i>Norbert J. Fliege</i>	2385
78	The Current Generalized Immittance Converter (CGIC) Biquads <i>Wasfy B. Mikhael</i>	2410
79	High-Order Filters <i>Rolf Schaumann</i>	2432

80	Continuous-Time Integrated Filters <i>Rolf Schaumann</i>	2460
81	Switched Capacitor Filters <i>Edgar Sánchez-Sinencio and José Silva-Martínez</i>	2491

SECTION XVI Digital Filters

Section Editor:	<i>Y. C. Lim</i>	2523
82	FIR Filters	
82.1	Properties of FIR Filters <i>M. H. Er</i>	2525
82.2	Design of FIR Filters <i>M. H. Er, Andreas Antoniou, L. Montgomery Smith, Bruce W. Bomar, Y. C. Lim, and Tapiro Saramäki</i>	2525
83	IIR Filters	
83.1	Properties of IIR Filters <i>Sawasd Tantaratana</i>	2602
83.2	Design of IIR Filters <i>Sawasd Tantaratana</i>	2611
83.3	Wave Digital Filters <i>Stuart S. Lawson</i>	2634
83.4	Lattice Filters <i>Y. C. Lim</i>	2657
84	Finite Wordlength Effects <i>Bruce W. Bomar</i>	2662
85	Aliasing-Free Reconstruction Filter Bank <i>Truong Q. Nguyen</i>	2682
86	VLSI Implementation of Digital Filters <i>Joseph B. Evans</i>	2718
87	Two-Dimensional FIR Filters <i>R. Ansari and A. E. Cetin</i>	2732
88	Two-Dimensional IIR Filters <i>A. G. Constantinides and X. J. Xu</i>	2762

Indexes

Author Index	2815
Index of Tables	2816
Index of Figures	2818
Subject Index	2840