

CONTENTS

1	Overview	1
2	Linear Circuits	3
2.1	Resistors, 3	
2.2	Capacitors, 5	
2.3	Inductors, 9	
2.4	Voltage Sources and Current Sources, 10	
2.5	The Unit Step, the Exponential, and the Logarithmic Functions, 12	
2.6	R-C Circuits, 16	
2.6.1	Step Voltage Input, 17	
2.6.2	Pulse Voltage Input, 19	
2.6.3	Ramp Voltage Input, 20	
2.6.4	Sinewave Input, 22	
2.7	R-L Circuits, 25	
2.8	Series R-L-C Circuits, 26	
2.8.1	Step Voltage Input, 26	
2.8.2	Step Voltage Input with Finite Risetime, 29	
2.8.3	Sinewave Input, 30	
2.8.4	Delay, Risetime, and Overshoot, 34	
2.9	Parallel-Series R-L-C Circuits, 35	
2.9.1	Step Current Input, 36	
2.9.2	Sinewave Input, 36	
2.9.3	Delay, Risetime, and Overshoot, 38	
2.10	Pulse Transformers, 39	
2.10.1	Step Voltage Input, 41	

x CONTENTS

2.10.2	Sinewave Input, 41
2.10.3	Delay, Risetime, and Overshoot, 43
†2.11	Cascaded Circuits, 44
2.11.1	Two-Stage R-C Circuits, 44
2.11.2	Multistage R-L-C Circuits, 49
2.11.3	Delay, Risetime, and Overshoot, 50
2.11.4	Summary, 50
	Problems, 56
	References, 58

3	Diode Circuits	59
----------	-----------------------	-----------

3.1	Junction Diodes, 59
3.1.1	DC Characteristics, 59
3.1.2	Piecewise Linear Approximations, 62
3.1.3	Stored Charge and Capacitances, 63
3.1.4	Transients in Junction Diode Circuits, 64
3.1.4.1	Transients with Diffusion Capacitance, 64
3.1.4.2	Transients with Stray Capacitance, 70
3.2	Computer-Aided Circuit Design, 73
3.2.1	DC Methods, 74
3.2.1.1	Graphical Methods, 74
3.2.1.2	Halving the Difference, 76
3.2.1.3	Spiraling in, 79
3.2.2	Transient Methods, 82
†3.3	Tunnel Diodes, 85
3.3.1	DC Characteristics, 85
3.3.2	Transients, 89
	Problems, 92
	References, 93

4	Transistors and Transistor Circuits	94
----------	--	-----------

4.1	Bipolar Transistors, 94
4.1.1	Basic Structure, 94
4.1.2	Basic DC Characteristics, 95

†Optional material is denoted by †.

- 4.1.3 The Forward Active Operating Region, 96
 - 4.1.3.1 Small-Signal Parameters, 98
- 4.1.4 Additional DC Properties, 99
- 4.1.5 Additional Operating Regions, 101
- 4.1.6 Capacitances, Stored Charge, Gain-Bandwidth Product, 101
- 4.1.7 Transistor Models, 105
- 4.2 Basic Transistor Circuits, 107
 - 4.2.1 The Grounded Base Stage, 109
 - 4.2.1.1 Small-Signal Response, 109
 - 4.2.1.2 Small-Signal Input Impedance, 110
 - 4.2.2 The Grounded Emitter Stage, 111
 - 4.2.2.1 Small-Signal Response, 111
 - 4.2.2.2 Large-Signal Response, 114
 - 4.2.3 The Emitter Follower, 115
 - 4.2.3.1 Input Impedance with Resistive Load, 116
 - 4.2.3.2 Input Impedance with Parallel R-C Load, 117
 - 4.2.3.3 Output Impedance with Resistive Source, 117
 - 4.2.3.4 Transient with Current Source Input, 118
 - 4.2.3.5 Transient with Voltage Source Input, 119
 - 4.2.3.6 Instabilities, 120
- 4.3 Schottky-Diode-Clamped TTL, 121
 - 4.3.1 Basic Properties, 121
 - 4.3.2 Noise Margins, 122
 - 4.3.3 DC Operation, 123
 - 4.3.4 Propagation Delays, 127
- 4.4 Emitter-Coupled Logic (ECL), 129
 - 4.4.1 Basic Operation, 129
 - 4.4.2 The Current-Mode Switching Pair, 131
 - 4.4.2.1 DC Characteristics, 132
 - 4.4.2.2 Delay and Risetime, 133
 - 4.4.2.3 Delay and Risetime Originating from Input Risetime t_G , 134
 - 4.4.2.4 Delay and Risetime Originating from External Capacitance C_{ext} , 135
 - 4.4.2.5 Delay and Risetime Originating from Timeconstant τ , 136

4.4.2.6 Simultaneous Effects of t_G , C_{ext} , and τ , 137	
4.4.2.7 Effects of a Capacitive Load at the Output, 137	
Problems, 138	
References, 140	
5 Transmission Lines	141
5.1 Basic Properties, 141	
5.1.1 Characteristic Impedance, 143	
5.1.2 Velocity of Signal Propagation, 144	
5.1.3 Propagation Delay, Capacitance, and Inductance, 144	
5.1.4 Transmission Line Configurations, 145	
5.2 Linear Resistive Termination, 148	
5.2.1 Termination by the Characteristic Impedance, 148	
5.2.2 Termination by an Open Circuit, 150	
5.2.3 Termination by a Short Circuit, 153	
5.2.4 Termination by an Arbitrary Resistance, 154	
5.2.5 Initial Conditions, 158	
5.3 Capacitive Termination, 159	
5.3.1 Transient Response, 160	
5.3.2 Multiple Reflections, 163	
5.4 Nonlinear Resistive Termination, 164	
5.4.1 The Graphical Method, 167	
5.4.2 Applications, 172	
†5.5 Losses, 174	
5.5.1 DC Resistance, 175	
5.5.2 Skin Effect, 176	
5.5.3 Additional Effects, 177	
Problems, 177	
References, 180	
Answers to Selected Problems	181
Index	183