

Contents

<i>Preface</i>	<i>Page</i> vii
<i>Acknowledgements</i>	ix
Part One Devices	1
1 Review of semiconductor materials and physics	3
1.1 Executive summary	3
1.2 Semiconductor materials	4
1.3 Types of solids	5
1.4 Crystal structure	5
1.5 Crystal directions and planes	6
1.6 Atomic bonding	8
1.7 Atomic physics	9
1.8 The de Broglie relation	11
1.9 Quantum mechanics	12
1.10 Statistical mechanics	16
1.11 Electrons in a semiconductor	16
1.12 The Kronig–Penney model	16
1.13 Semiconductors in equilibrium	18
1.14 Direct and indirect semiconductors	20
1.15 Recombination and radiation in semiconductors	25
1.16 Carrier transport in semiconductors	29
1.17 p–n junction	30
1.18 Schottky diode	34
1.19 Heterostructures	35
1.20 Silicon–germanium heterostructures	40
1.21 Problems	43
References	45
2 Electronic devices	46
2.1 Executive summary	46
2.2 MESFET	46
2.3 High electron mobility transistor	67

2.4	Radio Frequency MOSFETs	95
2.5	Bipolar and hetero-bipolar transistors	115
2.6	Problems	156
	References	158
3	Optimisation and parameter extraction of circuit models	163
3.1	Executive summary	163
3.2	Optimisation of device models	163
3.3	Simulated annealing	164
3.4	Neural networks applied to modelling	168
3.5	Optimisation of neural networks by the genetic algorithm	180
3.6	Structured genetic algorithm	181
3.7	Semi-analytical device parameter extraction	184
3.8	Basic expressions for small-signal parameter extraction	203
3.9	Small-signal model of the collector-up (inverted) HBT	212
3.10	Problems	214
	References	218
4	Optoelectronics	221
4.1	Executive summary	221
4.2	Optical sources	221
4.3	Photodetectors	261
4.4	Problems	284
	References	285
	Part Two Circuits	289
5	Building blocks for high-speed analogue circuits	291
5.1	Executive summary	291
5.2	Basic relations for two-port networks	291
5.3	Noise in two-ports	306
5.4	Transistor amplifiers	313
5.5	Oscillators	383
5.6	Mixers	396
5.7	Baluns, unbals and hybrids	412
5.8	Problems	419
	References	421
	<i>Index</i>	423