
Contents

Preface	ix
Chapter 1. Number Systems	1
1.1. Introduction	1
1.2. Decimal numbers	1
1.3. Binary numbers	2
1.4. Octal numbers	4
1.5. Hexadecimal numeration	5
1.6. Representation in a radix B	6
1.7. Binary-coded decimal numbers	7
1.8. Representations of signed integers	8
1.8.1. Sign-magnitude representation	9
1.8.2. Two's complement representation	10
1.8.3. Excess-E representation	12
1.9. Representation of the fractional part of a number	13
1.10. Arithmetic operations on binary numbers	16
1.10.1. Addition	16
1.10.2. Subtraction	17
1.10.3. Multiplication	18
1.10.4. Division	19
1.11. Representation of real numbers	20
1.11.1. Fixed-point representation	20
1.11.2. Floating-point representation	22
1.12. Data representation	28
1.12.1. Gray code	28
1.12.2. p-out-of-n code	29
1.12.3. ASCII code	31
1.12.4. Other codes	31
1.13. Codes to protect against errors	31

1.13.1. Parity bit	31
1.13.2. Error correcting codes	33
1.14. Exercises	36
1.15. Solutions	38
Chapter 2. Logic Gates	49
2.1. Introduction	49
2.2. Logic gates	50
2.2.1. NOT gate	51
2.2.2. AND gate	51
2.2.3. OR gate	52
2.2.4. XOR gate	52
2.2.5. Complementary logic gates	53
2.3. Three-state buffer	54
2.4. Logic function	54
2.5. The correspondence between a truth table and a logic function	55
2.6. Boolean algebra	57
2.6.1. Boolean algebra theorems	59
2.6.2. Karnaugh maps	65
2.6.3. Simplification of logic functions with multiple outputs	73
2.6.4. Factorization of logic functions	74
2.7. Multi-level logic circuit implementation	76
2.7.1. Examples	77
2.7.2. NAND gate logic circuit	78
2.7.3. NOR gate based logic circuit	80
2.7.4. Representation based on XOR and AND operators	82
2.8. Practical considerations	89
2.8.1. Timing diagram for a logic circuit	90
2.8.2. Static hazard	90
2.8.3. Dynamic hazard	92
2.9. Demonstration of some Boolean algebra identities	93
2.10. Exercises	97
2.11. Solutions	101
Chapter 3. Function Blocks of Combinational Logic	115
3.1. Introduction	115
3.2. Multiplexer	115
3.3. Demultiplexer and decoder	121
3.4. Implementation of logic functions using multiplexers or decoders	127
3.4.1. Multiplexer	127
3.4.2. Decoder	129
3.5. Encoders	130
3.5.1. 4:2 encoder	131

3.5.2. 8:3 encoder	134
3.5.3. Priority encoder	136
3.6. Transcoders	143
3.6.1. Binary code and Gray code	143
3.6.2. BCD and excess-3 code	149
3.7. Parity check generator	155
3.8. Barrel shifter	160
3.9. Exercises	165
3.10. Solutions	173
Chapter 4. Systematic Methods for the Simplification of Logic Functions	203
4.1. Introduction	203
4.2. Definitions and reminders	203
4.2.1. Definitions	204
4.2.2. Minimization principle of a logic function	204
4.3. Karnaugh maps	205
4.3.1. Function of five variables	205
4.3.2. Function of six variables	207
4.3.3. Karnaugh map with entered variable	208
4.3.4. Applications	215
4.3.5. Representation based on the XOR and AND operators	220
4.4. Systematic methods for simplification	220
4.4.1. Determination of prime implicants	221
4.4.2. Finding the constitutive terms of a minimal expression	224
4.4.3. Quine–McCluskey technique: simplification of incompletely defined functions	235
4.4.4. Simplification of functions with multiple outputs	235
4.5. Exercises	241
4.6. Solutions	243
Bibliography	257
Index	259
