Contents

Introduction 1
How Were the Exercises Selected? 1
How Can I Use This Manual? 1
How Is This Manual Organized Anyway? 2
Some General Problem-Solving Strategies 2
Remember, It Is a Quantitative Approach 2
Relevant Section Numbers 3
Making Assumptions 3
Pipeline Diagrams 3
Closing Remarks & Acknowledgements 3

1 Fundamentals of Computer Design 5
Introduction to the Chapter 1 Exercises 5
Exercise 1.1 7
Exercise 1.2 10
Exercise 1.3 11
Exercise 1.4 12
Exercise 1.5 14
Exercise 1.6 17
Exercise 1.7 18
Exercise 1.8 21
Exercise 1.9 27
Exercise 1.10 28
Exercise 1.11 28
Exercise 1.12 30
Exercise 1.13 33
Exercise 1.14 35
Exercise 1.15 37

2 Instruction Set Principles and Examples **39**
Introduction to the Chapter 2 Exercises . . . 39
Exercise 2.1 . . . 40
Exercise 2.2 . . . 43
Exercise 2.3 . . . 44
Exercise 2.5 . . . 47
Introduction to Exercises 2.6–2.9 . . . 47
Exercise 2.6 . . . 48
Exercise 2.7 . . . 50
Exercise 2.8 . . . 52
Exercise 2.9 . . . 53
Exercise 2.10 . . . 54
Exercise 2.11 . . . 55
Exercise 2.12 . . . 56

3 Pipelining **59**
Introduction to the Chapter 3 Exercises . . . 59
Exercise 3.1 . . . 60
Exercise 3.2 . . . 65
Exercise 3.3 . . . 68
Exercise 3.4 . . . 80
Exercise 3.5 . . . 81
Exercise 3.6 . . . 82
Exercise 3.7 . . . 83
Exercise 3.8 . . . 84
Exercise 3.9 . . . 85
Exercise 3.10 . . . 89
Exercise 3.11 . . . 94
Exercise 3.12 . . . 95
Exercise 3.13 . . . 96
Exercise 3.14 . . . 98
Exercise 3.15 . . . 99

4 Advanced Pipelining and Instruction-Level Parallelism **101**
Introduction to the Chapter 4 Exercises . . . 101
Exercise 4.1 . . . 103
Exercise 4.2 . . . 103
Exercise 4.3 . . . 104
Exercise 4.4 . . . 105

Exercise 4.5 . . . 106
Exercise 4.6 . . . 107
Exercise 4.7 . . . 108
Exercise 4.8 . . . 109
Exercise 4.10 . . . 110
Exercise 4.11 . . . 112
Exercise 4.14 . . . 114
The Classic Five-Stage DLX . . . 115
The DLX with Scoreboarding . . . 115
The Tomasulo DLX . . . 117
Exercise 4.15 . . . 146
Exercise 4.16 . . . 147
Exercise 4.17 . . . 147
Exercise 4.18 . . . 148
Exercise 4.19 . . . 150
Exercise 4.20 . . . 150

5 Memory-Hierarchy Design **155**
Introduction to the Chapter 5 Exercises . . . 155
Exercise 5.1 . . . 156
Exercise 5.3 . . . 160
Exercise 5.4 . . . 161
Exercise 5.5 . . . 165
Exercise 5.6 . . . 169
Exercise 5.7 . . . 172
Exercise 5.8 . . . 173
Exercise 5.9 . . . 177
Exercise 5.10 . . . 178
Exercise 5.14 . . . 181

6 Storage Systems **183**
Introduction to the Chapter 6 Exercises . . . 183
About the Fallacy on Page 549 and Figures 6.43 and 6.2 . . . 184
Exercise 6.1 . . . 185
Exercise 6.3 . . . 185
Exercise 6.4 . . . 185
Exercise 6.5 . . . 186
Exercise 6.6 . . . 189
Exercise 6.7 . . . 191

Exercise 6.8 191
Exercise 6.9 191
Exercise 6.10 192
Exercise 6.16 199
Exercise 6.17 199
Exercise 6.19 200

7 Interconnection Networks **201**
Introduction to the Chapter 7 Exercises 201
Exercise 7.1 202
Exercise 7.2 203
Exercise 7.3 204
Exercise 7.5 206
Exercise 7.6 207
Exercise 7.7 208
Exercise 7.8 209
Exercise 7.9 211
Exercise 7.10 212
Exercise 7.12 212
Exercise 7.13 213
Exercise 7.14 217

8 Multiprocessors **219**
Introduction to the Chapter 8 Exercises 219
Exercise 8.1 220
Exercise 8.2 221
Exercise 8.3 222
Exercise 8.4 224
Exercise 8.5 225
Exercise 8.7 225
Exercise 8.9 227
Exercise 8.13 228
Exercise 8.14 229
Exercise 8.22 230
Exercise 8.23 231

A Computer Arithmetic **233**
Introduction to the Appendix A Exercises 233
Exercise A.1 235

Exercise A.3 235
Exercise A.4 235
Exercise A.5 236
Exercise A.6 237
Exercise A.7 237
Exercise A.8 239
Exercise A.10 239
Exercise A.11 239
Exercise A.12 240
Exercise A.13 241
Exercise A.14 242
Exercise A.15 243
Exercise A.18 243
Exercise A.20 244
Exercise A.21 248
Exercise A.26 249
Exercise A.27 250
Exercise A.28 252
Exercise A.32 252

B Vector Processors **253**
Introduction to the Appendix B Exercises 253
Convoys, Chimes, and Cycles 254
Exercise B.1 256
Exercise B.2 257
Exercise B.3 261
Exercise B.4 268
Exercise B.5 269
Exercise B.6 270
Exercise B.7 274
Exercise B.8 277
Exercise B.9 281
Exercise B.10 281
Exercise B.11 283