Contents

Preface xi

Suggested Lecture Schedule xvii

1

Yes, There are Proofs! 1

- 1.1 Compound Statements 2
- 1.2 Proofs in Mathematics 9
- 1.3 Truth Tables 17
- 1.4 The Algebra of Propositions 21
- 1.5 Logical Arguments 28 Review Exercises 34

2

Sets and Relations 37

- 2.1 Sets 37
- 2.2 Operations on Sets 43
- 2.3 Binary Relations 51
- 2.4 Equivalence Relations 56
- 2.5 Partial Orders 63 Review Exercises 68

Functions 71

- 3.1 Domain, Range, One-to-One, Onto 71
- 3.2 Inverses and Composition 79
- 3.3 One-to-One Correspondence and the Cardinality of a Set 87 Review Exercises 95

4

The Integers 97

- 4.1 The Division Algorithm 97
- 4.2 Divisibility and the Euclidean Algorithm 104
- 4.3 Prime Numbers 114
- 4.4 Congruence 126
- 4.5 Applications of Congruence 136 Review Exercises 147

Induction and Recursion 149

- 5.1 Mathematical Induction 149
- 5.2 Recursively Defined Sequences 163
- 5.3 Solving Recurrence Relations; The Characteristic Polynomial 173
- 5.4 Solving Recurrence Relations; Generating Functions 178 Review Exercises 185

6 Principles of Counting 187

- 6.1 The Principle of Inclusion–Exclusion 187
- 6.2 The Addition and Multiplication Rules 196
- 6.3 The Pigeon-Hole Principle 204 Review Exercises 209

7 Permutations and Combinations 211

- 7.1 Permutations 211
- 7.2 Combinations 216
- 7.3 Repetitions 223
- 7.4 Derangements 228
- 7.5 The Binomial Theorem 231 Review Exercises 237

Algorithms 239

- 8.1 What Is an Algorithm? 239
- 8.2 Complexity 246
- 8.3 Searching and Sorting 259
- 8.4 Enumeration of Permutations and Combinations 271 Review Exercises 275

Graphs 277

- 9.1 A Gentle Introduction 277
- 9.2 Definitions and Basic Properties 286
- 9.3 Isomorphism 294 Review Exercises 299

10 Paths and Circuits 303

- 10.1 Eulerian Circuits 303
- 10.2 Hamiltonian Cycles 310
- 10.3 The Adjacency Matrix 318
- 10.4 Shortest Path Algorithms 325 Review Exercises 333

1 Applications of Paths and Circuits 337

11.1 The Chinese Postman Problem 337

11.2 Digraphs 342

11.3 RNA Chains 350

11.4 Tournaments 355

11.5 Scheduling Problems 360 Review Exercises 365

7 Trees 367

12.1 What Is a Tree? 367

12.2 Properties of Trees 372

12.3 Spanning Trees 377

12.4 Minimum Spanning Tree Algorithms 382

12.5 Acyclic Digraphs and Bellman's Algorithm 392

Review Exercises 397

3 Depth-First Search and Applications 399

13.1 Depth-First Search 399

13.2 The One-Way Street Problem 405 Review Exercises 411

1 Planar Graphs and Colorings 413

14.1 Planar Graphs 413

14.2 Coloring Graphs 421

14.3 Circuit Testing and Facilities Design 430 Review Exercises 438

15

The Max Flow — Min Cut Theorem 441

15.1 Flows and Cuts 441

15.2 Constructing Maximal Flows 448

15.3 Applications 454

15.4 Matchings 459

Review Exercises 464

Solutions to Selected Exercises S-1

Glossary G-1

Index I-1

the appears, it is easy to cheat/by turning over the page and looking at the answer, but that, use, is not the way to learn mathematics!

We believe that writing skills are tetribly important, so, in this edition, we have highlighted some exercises where we expect answers to be written in complete sentences and good English.