

Preface ix

1 Problem Solving

Strategies and Principles 1

- 1.1 Problem Solving 2
- 1.2 Inductive and Deductive Reasoning 18
- 1.3 Estimation 28
- Chapter Summary 38**
- Chapter Review Exercises 38**
- Chapter Test 39**

2 Set Theory

Using Mathematics to Classify Objects 42

- 2.1 The Language of Sets 43
- 2.2 Comparing Sets 50
- 2.3 Set Operations 57
- 2.4 Survey Problems 67
- 2.5 **Looking Deeper:** Infinite Sets 76
- Chapter Summary 81**
- Chapter Review Exercises 81**
- Chapter Test 83**

3 Logic

The Study of What's True or False or Somewhere in Between 85

- 3.1 Statements, Connectives, and Quantifiers 86
- 3.2 Truth Tables 95
- 3.3 The Conditional and Biconditional 106
- 3.4 Verifying Arguments 115
- 3.5 Using Euler Diagrams to Verify Syllogisms 123
- 3.6 **Looking Deeper:** Fuzzy Logic 130
- Chapter Summary 137**
- Chapter Review Exercises 138**
- Chapter Test 139**

4 Graph Theory (Networks)

The Mathematics of Relationships 142

- 4.1 Graphs, Puzzles, and Map Coloring 143
- 4.2 The Traveling Salesperson Problem 157
- 4.3 Directed Graphs 168
- 4.4 **Looking Deeper:** Scheduling Projects Using PERT 175
- Chapter Summary 184**
- Chapter Review Exercises 185**
- Chapter Test 186**

5 Numeration Systems

Does It Matter How We Name Numbers? 190

- 5.1 The Evolution of Numeration Systems 191
- 5.2 Place Value Systems 200
- 5.3 Calculating in Other Bases 209
- 5.4 **Looking Deeper:** Modular Systems 221
- Chapter Summary 229**
- Chapter Review Exercises 230**
- Chapter Test 230**

6 Number Theory and the Real Number System

Understanding the Numbers All Around Us 232

- 6.1 Number Theory 233
- 6.2 The Integers 245
- 6.3 The Rational Numbers 253
- 6.4 The Real Number System 265
- 6.5 Exponents and Scientific Notation 275
- 6.6 **Looking Deeper:** Sequences 285
- Chapter Summary 295**
- Chapter Review Exercises 297**
- Chapter Test 298**

7 Algebraic Models**How Do We Approximate Reality? 300**

- 7.1 Linear Equations 301
- 7.2 Modeling with Linear Equations 313
- 7.3 Modeling with Quadratic Equations 321
- 7.4 Exponential Equations and Growth 330
- 7.5 Proportions and Variation 340
- 7.6 Modeling with Systems of Linear Equations and Inequalities 348
- 7.7 **Looking Deeper:** Dynamical Systems 364
- Chapter Summary 371**
- Chapter Review Exercises 372**
- Chapter Test 374**

8 Consumer Mathematics**The Mathematics of Everyday Life 378**

- 8.1 Percents, Taxes, and Inflation 379
- 8.2 Interest 388
- 8.3 Consumer Loans 399
- 8.4 Annuities 408
- 8.5 Amortization 416
- 8.6 **Looking Deeper:** Annual Percentage Rate 424
- Chapter Summary 431**
- Chapter Review Exercises 433**
- Chapter Test 434**

9 Geometry**Ancient and Modern Mathematics Embrace 436**

- 9.1 Lines, Angles, and Circles 437
- 9.2 Polygons 446
- 9.3 Perimeter and Area 456
- 9.4 Volume and Surface Area 468
- 9.5 The Metric System and Dimensional Analysis 477
- 9.6 Geometric Symmetry and Tessellations 488
- 9.7 **Looking Deeper:** Fractals 500
- Chapter Summary 509**
- Chapter Review Exercises 511**
- Chapter Test 512**

10 Apportionment**How Do We Measure Fairness? 516**

- 10.1 Understanding Apportionment 517
- 10.2 The Huntington–Hill Apportionment Principle 525
- 10.3 Other Paradoxes and Apportionment Methods 534
- 10.4 **Looking Deeper:** Fair Division 548
- Chapter Summary 556**
- Chapter Review Exercises 557**
- Chapter Test 558**

11 Voting**Using Mathematics to Make Choices 561**

- 11.1 Voting Methods 562
- 11.2 Defects in Voting Methods 572
- 11.3 Weighted Voting Systems 583
- 11.4 **Looking Deeper:** The Shapley–Shubik Index 592
- Chapter Summary 600**
- Chapter Review Exercises 601**
- Chapter Test 602**

12 Counting**Just How Many Are There? 605**

- 12.1 Introduction to Counting Methods 606
- 12.2 The Fundamental Counting Principle 614
- 12.3 Permutations and Combinations 622
- 12.4 **Looking Deeper:** Counting and Gambling 635
- Chapter Summary 640**
- Chapter Review Exercises 641**
- Chapter Test 641**

13 Probability**What Are the Chances? 643**

- 13.1 The Basics of Probability Theory 644
- 13.2 Complements and Unions of Events 659
- 13.3 Conditional Probability and Intersections of Events 668

- 13.4** Expected Value 682
- 13.5** **Looking Deeper:** Binomial Experiments 691
- Chapter Summary** 697
- Chapter Review Exercises** 698
- Chapter Test** 699

14 Descriptive Statistics

What a Data Set Tells Us 701

- 14.1** Organizing and Visualizing Data 702
- 14.2** Measures of Central Tendency 714
- 14.3** Measures of Dispersion 727
- 14.4** The Normal Distribution 738
- 14.5** **Looking Deeper:** Linear Correlation 751
- Chapter Summary** 759
- Chapter Review Exercises** 760
- Chapter Test** 761

Appendix A 764

Answers to Quiz Yourself Problems 767

Answers to Exercises 775

Credits C1

Index I1