

<b>CHAPTER 0</b>	<b>Algebra Refresher</b>	<b>1</b>
	0.1 Purpose	2
	0.2 Sets and Real Numbers	2
	0.3 Some Properties of Real Numbers	3
	0.4 Operations with Real Numbers	7
	0.5 Exponents and Radicals	10
	0.6 Operations with Algebraic Expressions	18
	0.7 Factoring	23
	0.8 Fractions	26
	<b>Mathematical Snapshot:</b> Modeling Load Cell Behavior	33
<b>CHAPTER 1</b>	<b>Equations</b>	<b>35</b>
	1.1 Linear Equations	36
	1.2 Equations Leading to Linear Equations	43
	1.3 Quadratic Equations	47
	1.4 Supplement	55
	1.5 Review	56
	<b>Mathematical Snapshot:</b> Real Growth of an Investment	58
<b>CHAPTER 2</b>	<b>Applications of Equations and Inequalities</b>	<b>61</b>
	2.1 Applications of Equations	62
	2.2 Linear Inequalities	70
	2.3 Applications of Inequalities	75
	2.4 Absolute Value	79
	2.5 Review	83
	<b>Mathematical Snapshot:</b> Variable-Quality Recording	85
<b>CHAPTER 3</b>	<b>Functions and Graphs</b>	<b>87</b>
	3.1 Functions	88
	3.2 Special Functions	95
	3.3 Combinations of Functions	99
	3.4 Graphs in Rectangular Coordinates	104

- 3.5 Symmetry 115
- 3.6 Translations and Reflections 120
- 3.7 Review 122
- Mathematical Snapshot:** A Taxing Experience! 125

## CHAPTER 4 Lines, Parabolas, and Systems 127

- 4.1 Lines 128
- 4.2 Applications and Linear Functions 136
- 4.3 Quadratic Functions 144
- 4.4 Systems of Linear Equations 152
- 4.5 Nonlinear Systems 163
- 4.6 Applications of Systems of Equations 166
- 4.7 Review 176
- Mathematical Snapshot:** Wireless Phone Billing Plans 179

## CHAPTER 5 Exponential and Logarithmic Functions 181

- 5.1 Exponential Functions 182
- 5.2 Logarithmic Functions 195
- 5.3 Properties of Logarithms 202
- 5.4 Logarithmic and Exponential Equations 210
- 5.5 Review 216
- Mathematical Snapshot:** Drug Dosages 220

## CHAPTER 6 Matrix Algebra 223

- 6.1 Matrices 224
- 6.2 Matrix Addition and Scalar Multiplication 231
- 6.3 Matrix Multiplication 239
- 6.4 Method of Reduction 252
- 6.5 Method of Reduction (Continued) 262
- 6.6 Inverses 268
- 6.7 Determinants 277
- 6.8 Cramer's Rule 286
- 6.9 Input-Output Analysis with a Graphics Calculator 291
- 6.10 Review 295
- Mathematical Snapshot:** Insulin Requirements as a Linear Process 298

## CHAPTER 7 Linear Programming 301

- 7.1 Linear Inequalities in Two Variables 302
- 7.2 Linear Programming 307

- 7.3 Multiple Optimum Solutions 317
- 7.4 The Simplex Method 319
- 7.5 Degeneracy, Unbounded Solutions, and Multiple Optimum Solutions 332
- 7.6 Artificial Variables 338
- 7.7 Minimization 349
- 7.8 The Dual 354
- 7.9 Review 362
- Mathematical Snapshot:** Drug and Radiation Therapies 365

## CHAPTER 8 Mathematics of Finance 367

---

- 8.1 Compound Interest 368
- 8.2 Present Value 373
- 8.3 Annuities 378
- 8.4 Amortization of Loans 388
- 8.5 Review 393
- Mathematical Snapshot:** Treasury Securities 395

## CHAPTER 9 Introduction to Probability and Statistics 397

---

- 9.1 Basic Counting Principle and Permutations 398
- 9.2 Combinations and Other Counting Principles 406
- 9.3 Sample Spaces and Events 414
- 9.4 Probability 423
- 9.5 Conditional Probability and Stochastic Processes 435
- 9.6 Independent Events 450
- 9.7 Bayes's Formula 461
- 9.8 Review 471
- Mathematical Snapshot:** Probability and Cellular Automata 477

## CHAPTER 10 Additional Topics in Probability 479

---

- 10.1 Discrete Random Variables and Expected Value 480
- 10.2 The Binomial Distribution 488
- 10.3 Markov Chains 493
- 10.4 Review 505
- Mathematical Snapshot:** Markov Chains in Game Theory 508

## CHAPTER 11 Limits and Continuity 511

---

- 11.1 Limits 512
- 11.2 Limits (Continued) 523
- 11.3 Interest Compounded Continuously 533

- 11.4 Continuity 536
- 11.5 Continuity Applied to Inequalities 544
- 11.6 Review 548
- Mathematical Snapshot:** National Debt 552

## CHAPTER 12 Differentiation 555

---

- 12.1 The Derivative 556
- 12.2 Rules for Differentiation 565
- 12.3 The Derivative as a Rate of Change 573
- 12.4 Differentiability and Continuity 584
- 12.5 Product and Quotient Rules 586
- 12.6 The Chain Rule and the Power Rule 597
- 12.7 Review 606
- Mathematical Snapshot:** Marginal Propensity to Consume 611

## CHAPTER 13 Additional Differentiation Topics 613

---

- 13.1 Derivatives of Logarithmic Functions 614
- 13.2 Derivatives of Exponential Functions 619
- 13.3 Implicit Differentiation 625
- 13.4 Logarithmic Differentiation 632
- 13.5 Higher-Order Derivatives 635
- 13.6 Review 639
- Mathematical Snapshot:** Population Change over Time 642

## CHAPTER 14 Curve Sketching 645

---

- 14.1 Relative Extrema 646
- 14.2 Absolute Extrema on a Closed Interval 657
- 14.3 Concavity 660
- 14.4 The Second-Derivative Test 668
- 14.5 Asymptotes 670
- 14.6 Review 680
- Mathematical Snapshot:** Sketching the Phillips Curve 684

## CHAPTER 15 Applications of Differentiation 687

---

- 15.1 Applied Maxima and Minima 688
- 15.2 Differentials 701
- 15.3 Elasticity of Demand 707
- 15.4 Newton's Method 712
- 15.5 Review 717
- Mathematical Snapshot:** Economic Order Quantity 720

<b>CHAPTER 16</b>	<b>Integration</b>	<b>723</b>
16.1	The Indefinite Integral	724
16.2	Integration with Initial Conditions	731
16.3	More Integration Formulas	736
16.4	Techniques of Integration	745
16.5	Summation	751
16.6	The Definite Integral	754
16.7	The Fundamental Theorem of Integral Calculus	763
16.8	Area	774
16.9	Area Between Curves	778
16.10	Consumers' and Producers' Surplus	786
16.11	Review	789
	<b>Mathematical Snapshot:</b> Delivered Price	794
<b>CHAPTER 17</b>	<b>Methods and Applications of Integration</b>	<b>797</b>
17.1	Integration by Parts	798
17.2	Integration by Partial Fractions	803
17.3	Integration by Tables	810
17.4	Average Value of a Function	816
17.5	Approximate Integration	819
17.6	Differential Equations	824
17.7	More Applications of Differential Equations	832
17.8	Improper Integrals	840
17.9	Review	844
	<b>Mathematical Snapshot:</b> Dieting	848
<b>CHAPTER 18</b>	<b>Continuous Random Variables</b>	<b>851</b>
18.1	Continuous Random Variables	852
18.2	The Normal Distribution	860
18.3	The Normal Approximation to the Binomial Distribution	866
18.4	Review	870
	<b>Mathematical Snapshot:</b> Cumulative Distribution from Data	873
<b>CHAPTER 19</b>	<b>Multivariable Calculus</b>	<b>875</b>
19.1	Functions of Several Variables	876
19.2	Partial Derivatives	882
19.3	Applications of Partial Derivatives	889
19.4	Implicit Partial Differentiation	896
19.5	Higher-Order Partial Derivatives	899
19.6	Chain Rule	902

<b>19.7</b>	Maxima and Minima for Functions of Two Variables	906
<b>19.8</b>	Lagrange Multipliers	916
<b>19.9</b>	Lines of Regression	924
<b>19.10</b>	A Comment on Homogeneous Functions	931
<b>19.11</b>	Multiple Integrals	933
<b>19.12</b>	Review	937
	<b>Mathematical Snapshot:</b> Data Analysis to Model Cooling	941

### ***Appendix A Concepts for Calculus 943***

<b>A.1</b>	Interpreting Graphs	944
<b>A.2</b>	Modeling	950
<b>A.3</b>	Average Rate of Change	956
<b>A.4</b>	Instantaneous Rate of Change: The Derivative	962
<b>A.5</b>	Area Under a Curve	968
<b>A.6</b>	Sigma Notation	973
<b>A.7</b>	Areas and Integrals	977
<b>A.8</b>	Applications of Derivatives and Integrals	986
<b>A.9</b>	Review	994

### ***Appendix B Compound Interest Tables 999***

### ***Appendix C Table of Selected Integrals 1015***

### ***Appendix D Areas Under the Standard Normal Curve 1019***

### ***Answers to Odd-Numbered Problems AN1***

### ***Index I1***

### ***Photo Credits I8***