

# Contents

<i>About the Author</i>	v
<i>Preface to the Instructor</i>	xiii
<i>WileyPLUS</i>	xviii
<i>Acknowledgments</i>	xix
<i>Preface to the Student</i>	xxi
<b>1 The Real Numbers</b>	<b>1</b>
1.1 The Real Line	2
Construction of the Real Line	2
Is Every Real Number Rational?	3
Problems	6
1.2 Algebra of the Real Numbers	7
Commutativity and Associativity	7
The Order of Algebraic Operations	8
The Distributive Property	10
Additive Inverses and Subtraction	11
Multiplicative Inverses and the Algebra of Fractions	13
Symbolic Calculators	16
Exercises, Problems, and Worked-out Solutions	19
1.3 Inequalities, Intervals, and Absolute Value	24
Positive and Negative Numbers	24
Lesser and Greater	25
Intervals	27
Absolute Value	30
Exercises, Problems, and Worked-out Solutions	33
Chapter Summary and Chapter Review Questions	40

<b>2</b>	<b><i>Combining Algebra and Geometry</i></b>	<b>41</b>
2.1	The Coordinate Plane	42
	Coordinates	42
	Graphs of Equations	44
	Distance Between Two Points	46
	Length, Perimeter, and Circumference	48
	Exercises, Problems, and Worked-out Solutions	50
2.2	Lines	57
	Slope	57
	The Equation of a Line	58
	Parallel Lines	61
	Perpendicular Lines	62
	Midpoints	64
	Exercises, Problems, and Worked-out Solutions	66
2.3	Quadratic Expressions and Conic Sections	75
	Completing the Square	75
	The Quadratic Formula	77
	Circles	79
	Ellipses	81
	Parabolas	83
	Hyperbolas	85
	Exercises, Problems, and Worked-out Solutions	88
2.4	Area	98
	Squares, Rectangles, and Parallelograms	98
	Triangles and Trapezoids	99
	Stretching	101
	Circles and Ellipses	102
	Exercises, Problems, and Worked-out Solutions	105
	Chapter Summary and Chapter Review Questions	115
<b>3</b>	<b><i>Functions and Their Graphs</i></b>	<b>117</b>
3.1	Functions	118
	Definition and Examples	118
	The Graph of a Function	121
	The Domain of a Function	124
	The Range of a Function	126

Functions via Tables	128
Exercises, Problems, and Worked-out Solutions	129
<b>3.2 Function Transformations and Graphs</b>	<b>142</b>
Vertical Transformations: Shifting, Stretching, and Flipping	142
Horizontal Transformations: Shifting, Stretching, Flipping	145
Combinations of Vertical Function Transformations	149
Even Functions	152
Odd Functions	153
Exercises, Problems, and Worked-out Solutions	154
<b>3.3 Composition of Functions</b>	<b>165</b>
Combining Two Functions	165
Definition of Composition	166
Order Matters in Composition	169
Decomposing Functions	170
Composing More than Two Functions	171
Function Transformations as Compositions	172
Exercises, Problems, and Worked-out Solutions	174
<b>3.4 Inverse Functions</b>	<b>180</b>
The Inverse Problem	180
One-to-one Functions	181
The Definition of an Inverse Function	182
The Domain and Range of an Inverse Function	184
The Composition of a Function and Its Inverse	185
Comments About Notation	187
Exercises, Problems, and Worked-out Solutions	189
<b>3.5 A Graphical Approach to Inverse Functions</b>	<b>197</b>
The Graph of an Inverse Function	197
Graphical Interpretation of One-to-One	199
Increasing and Decreasing Functions	200
Inverse Functions via Tables	203
Exercises, Problems, and Worked-out Solutions	204
Chapter Summary and Chapter Review Questions	209
<b>4 Polynomial and Rational Functions</b>	<b>213</b>
<b>4.1 Integer Exponents</b>	<b>214</b>
Positive Integer Exponents	214

Properties of Exponents	215
Defining $x^0$	217
Negative Integer Exponents	218
Manipulations with Exponents	219
Exercises, Problems, and Worked-out Solutions	221
<b>4.2 Polynomials</b>	<b>227</b>
The Degree of a Polynomial	227
The Algebra of Polynomials	228
Zeros and Factorization of Polynomials	230
The Behavior of a Polynomial Near $\pm\infty$	234
Graphs of Polynomials	237
Exercises, Problems, and Worked-out Solutions	239
<b>4.3 Rational Functions</b>	<b>245</b>
Ratios of Polynomials	245
The Algebra of Rational Functions	246
Division of Polynomials	247
The Behavior of a Rational Function Near $\pm\infty$	250
Graphs of Rational Functions	253
Exercises, Problems, and Worked-out Solutions	255
<b>4.4 Complex Numbers</b>	<b>262</b>
The Complex Number System	262
Arithmetic with Complex Numbers	263
Complex Conjugates and Division of Complex Numbers	264
Zeros and Factorization of Polynomials, Revisited	268
Exercises, Problems, and Worked-out Solutions	271
Chapter Summary and Chapter Review Questions	276
<b>5 Exponents and Logarithms</b>	<b>279</b>
<b>5.1 Exponents and Exponential Functions</b>	<b>280</b>
Roots	280
Rational Exponents	284
Real Exponents	285
Exponential Functions	286
Exercises, Problems, and Worked-out Solutions	287
<b>5.2 Logarithms as Inverses of Exponential Functions</b>	<b>293</b>
Logarithms Base 2	293

Logarithms with Any Base	295
Common Logarithms and the Number of Digits	297
Logarithm of a Power	297
Radioactive Decay and Half-Life	299
Exercises, Problems, and Worked-out Solutions	301
<b>5.3 Applications of Logarithms</b>	<b>310</b>
Logarithm of a Product	310
Logarithm of a Quotient	311
Earthquakes and the Richter Scale	312
Sound Intensity and Decibels	313
Star Brightness and Apparent Magnitude	315
Change of Base	316
Exercises, Problems, and Worked-out Solutions	319
<b>5.4 Exponential Growth</b>	<b>328</b>
Functions with Exponential Growth	329
Population Growth	333
Compound Interest	335
Exercises, Problems, and Worked-out Solutions	340
Chapter Summary and Chapter Review Questions	347
<b>6 <i>e</i> and the Natural Logarithm</b>	<b>349</b>
<b>6.1 Defining <i>e</i> and <math>\ln</math></b>	<b>350</b>
Estimating Area Using Rectangles	350
Defining <i>e</i>	352
Defining the Natural Logarithm	355
Properties of the Exponential Function and $\ln$	356
Exercises, Problems, and Worked-out Solutions	358
<b>6.2 Approximations and area with <i>e</i> and <math>\ln</math></b>	<b>366</b>
Approximation of the Natural Logarithm	366
Approximations with the Exponential Function	368
An Area Formula	369
Exercises, Problems, and Worked-out Solutions	372
<b>6.3 Exponential Growth Revisited</b>	<b>376</b>
Continuously Compounded Interest	376
Continuous Growth Rates	377
Doubling Your Money	378

Exercises, Problems, and Worked-out Solutions	380
Chapter Summary and Chapter Review Questions	385
<b>7 Systems of Equations</b>	<b>387</b>
7.1 Equations and Systems of Equations	388
Solving an Equation	388
Solving a System of Equations Graphically	391
Solving a System of Equations by Substitution	392
Exercises, Problems, and Worked-out Solutions	393
7.2 Solving Systems of Linear Equations	399
Linear Equations: How Many Solutions?	399
Systems of Linear Equations	402
Gaussian Elimination	404
Exercises, Problems, and Worked-out Solutions	406
7.3 Solving Systems of Linear Equations Using Matrices	411
Representing Systems of Linear Equations by Matrices	411
Gaussian Elimination with Matrices	413
Systems of Linear Equations with No Solutions	415
Systems of Linear Equations with Infinitely Many Solutions	416
How Many Solutions, Revisited	418
Exercises, Problems, and Worked-out Solutions	419
7.4 Matrix Algebra	424
Matrix Size	424
Adding and Subtracting Matrices	426
Multiplying a Matrix by a Number	427
Multiplying Matrices	428
The Inverse of a Matrix	433
Exercises, Problems, and Worked-out Solutions	440
Chapter Summary and Chapter Review Questions	445
<b>8 Sequences, Series, and Limits</b>	<b>447</b>
8.1 Sequences	448
Introduction to Sequences	448
Arithmetic Sequences	450
Geometric Sequences	451
Recursively Defined Sequences	454

Exercises, Problems, and Worked-out Solutions	456
<b>8.2 Series</b>	<b>463</b>
Sums of Sequences	463
Arithmetic Series	463
Geometric Series	466
Summation Notation	468
The Binomial Theorem	470
Exercises, Problems, and Worked-out Solutions	476
<b>8.3 Limits</b>	<b>483</b>
Introduction to Limits	483
Infinite Series	487
Decimals as Infinite Series	489
Special Infinite Series	491
Exercises, Problems, and Worked-out Solutions	493
Chapter Summary and Chapter Review Questions	496
<i>Photo Credits</i>	497
<i>Index</i>	499