

GLOBAL  
EDITION



# College Mathematics

*for Business, Economics, Life Sciences,  
and Social Sciences*

FOURTEENTH EDITION

Raymond A. Barnett • Michael R. Ziegler  
Karl E. Byleen • Christopher J. Stocker



# CONTENTS

Preface . . . . .	7
Diagnostic Prerequisite Test. . . . .	20
<b>Chapter 1 Functions and Graphs . . . . .</b>	<b>23</b>
1.1 Functions. . . . .	24
1.2 Elementary Functions: Graphs and Transformations . . . . .	38
1.3 Quadratic Functions . . . . .	50
1.4 Polynomial and Rational Functions . . . . .	66
1.5 Exponential Functions . . . . .	78
1.6 Logarithmic Functions . . . . .	88
Chapter 1 Summary and Review . . . . .	100
Review Exercises . . . . .	102
<b>Chapter 2 Mathematics of Finance . . . . .</b>	<b>108</b>
2.1 Simple Interest . . . . .	109
2.2 Compound and Continuous Compound Interest . . . . .	116
2.3 Future Value of an Annuity; Sinking Funds. . . . .	130
2.4 Present Value of an Annuity; Amortization . . . . .	138
Chapter 2 Summary and Review . . . . .	150
Review Exercises . . . . .	152
<b>Chapter 3 Systems of Linear Equations; Matrices . . . . .</b>	<b>156</b>
3.1 Review: Systems of Linear Equations in Two Variables . . . . .	157
3.2 Systems of Linear Equations and Augmented Matrices . . . . .	170
3.3 Gauss–Jordan Elimination . . . . .	179
3.4 Matrices: Basic Operations . . . . .	193
3.5 Inverse of a Square Matrix . . . . .	206
3.6 Matrix Equations and Systems of Linear Equations. . . . .	218
3.7 Leontief Input–Output Analysis . . . . .	226
Chapter 3 Summary and Review . . . . .	234
Review Exercises . . . . .	235
<b>Chapter 4 Linear Inequalities and Linear Programming . . . . .</b>	<b>239</b>
4.1 Linear Inequalities in Two Variables . . . . .	240
4.2 Systems of Linear Inequalities in Two Variables . . . . .	248
4.3 Linear Programming in Two Dimensions: A Geometric Approach .	254
Chapter 4 Summary and Review . . . . .	267
Review Exercises . . . . .	267
<b>Chapter 5 Linear Programming: The Simplex Method . . . . .</b>	<b>269</b>
5.1 The Table Method: An Introduction to the Simplex Method . . . . .	270
5.2 The Simplex Method: Maximization with Problem Constraints of the Form $\leq$ . . . . .	281

5.3	The Dual Problem: Minimization with Problem Constraints of the Form $\geq$ . . . . .	298
5.4	Maximization and Minimization with Mixed Problem Constraints . . . . .	312
	Chapter 5 Summary and Review . . . . .	329
	Review Exercises . . . . .	330
<b>Chapter 6</b>	<b>Logic, Sets, and Counting . . . . .</b>	<b>333</b>
6.1	Logic . . . . .	334
6.2	Sets . . . . .	343
6.3	Basic Counting Principles . . . . .	350
6.4	Permutations and Combinations . . . . .	359
	Chapter 6 Summary and Review . . . . .	371
	Review Exercises . . . . .	373
<b>Chapter 7</b>	<b>Probability . . . . .</b>	<b>376</b>
7.1	Sample Spaces, Events, and Probability . . . . .	377
7.2	Union, Intersection, and Complement of Events; Odds . . . . .	390
7.3	Conditional Probability, Intersection, and Independence . . . . .	403
7.4	Bayes' Formula . . . . .	417
7.5	Random Variable, Probability Distribution, and Expected Value . . . . .	425
	Chapter 7 Summary and Review . . . . .	434
	Review Exercises . . . . .	436
<b>Chapter 8</b>	<b>Limits and the Derivative . . . . .</b>	<b>441</b>
8.1	Introduction to Limits . . . . .	442
8.2	Infinite Limits and Limits at Infinity . . . . .	455
8.3	Continuity . . . . .	468
8.4	The Derivative . . . . .	480
8.5	Basic Differentiation Properties . . . . .	495
8.6	Differentials . . . . .	505
8.7	Marginal Analysis in Business and Economics . . . . .	512
	Chapter 8 Summary and Review . . . . .	523
	Review Exercises . . . . .	524
<b>Chapter 9</b>	<b>Additional Derivative Topics . . . . .</b>	<b>530</b>
9.1	The Constant e and Continuous Compound Interest . . . . .	531
9.2	Derivatives of Exponential and Logarithmic Functions . . . . .	537
9.3	Derivatives of Products and Quotients . . . . .	546
9.4	The Chain Rule . . . . .	554
9.5	Implicit Differentiation . . . . .	565
9.6	Related Rates . . . . .	572
9.7	Elasticity of Demand . . . . .	578
	Chapter 9 Summary and Review . . . . .	586
	Review Exercises . . . . .	587

<b>Chapter 10</b>	<b>Graphing and Optimization . . . . .</b>	<b>590</b>
10.1	First Derivative and Graphs . . . . .	591
10.2	Second Derivative and Graphs . . . . .	607
10.3	L'Hôpital's Rule . . . . .	624
10.4	Curve-Sketching Techniques . . . . .	633
10.5	Absolute Maxima and Minima . . . . .	646
10.6	Optimization . . . . .	654
	Chapter 10 Summary and Review . . . . .	667
	Review Exercises . . . . .	668
<b>Chapter 11</b>	<b>Integration . . . . .</b>	<b>672</b>
11.1	Antiderivatives and Indefinite Integrals . . . . .	673
11.2	Integration by Substitution . . . . .	685
11.3	Differential Equations; Growth and Decay . . . . .	697
11.4	The Definite Integral . . . . .	708
11.5	The Fundamental Theorem of Calculus . . . . .	719
11.6	Area Between Curves . . . . .	731
	Chapter 11 Summary and Review . . . . .	742
	Review Exercises . . . . .	745
<b>Chapter 12</b>	<b>Additional Integration Topics . . . . .</b>	<b>749</b>
12.1	Integration by Parts . . . . .	750
12.2	Other Integration Methods . . . . .	757
12.3	Applications in Business and Economics . . . . .	769
	Chapter 12 Summary and Review . . . . .	781
	Review Exercises . . . . .	783
<b>Chapter 13</b>	<b>Multivariable Calculus . . . . .</b>	<b>785</b>
13.1	Functions of Several Variables . . . . .	786
13.2	Partial Derivatives . . . . .	795
13.3	Maxima and Minima . . . . .	804
13.4	Maxima and Minima Using Lagrange Multipliers . . . . .	812
13.5	Method of Least Squares . . . . .	821
13.6	Double Integrals over Rectangular Regions . . . . .	832
13.7	Double Integrals over More General Regions . . . . .	841
	Chapter 13 Summary and Review . . . . .	850
	Review Exercises . . . . .	852
<b>Chapter 14</b>	<b>Markov Chains (online) . . . . .</b>	<b>M2</b>
14.1	Properties of Markov Chains . . . . .	M3
14.2	Regular Markov Chains . . . . .	M14
14.3	Absorbing Markov Chains . . . . .	M25
	Chapter 14 Summary and Review . . . . .	M39
	Review Exercises . . . . .	M40

<b>Appendix A</b>	<b>Linear Equations and Graphs . . . . .</b>	<b>855</b>
	A.1 Linear Equations and Inequalities . . . . .	856
	A.2 Graphs and Lines . . . . .	866
	A.3 Linear Regression . . . . .	880
<b>Appendix B</b>	<b>Basic Algebra Review . . . . .</b>	<b>892</b>
	B.1 Real Numbers . . . . .	892
	B.2 Operations on Polynomials . . . . .	898
	B.3 Factoring Polynomials . . . . .	904
	B.4 Operations on Rational Expressions . . . . .	910
	B.5 Integer Exponents and Scientific Notation . . . . .	916
	B.6 Rational Exponents and Radicals . . . . .	920
	B.7 Quadratic Equations . . . . .	926
<b>Appendix C</b>	<b>Special Topics (online) . . . . .</b>	<b>A1</b>
	C.1 Sequences, Series, and Summation Notation . . . . .	A1
	C.2 Arithmetic and Geometric Sequences . . . . .	A7
	C.3 Binomial Theorem . . . . .	A13
	C.4 Interpolating Polynomials and Divided Differences . . . . .	A16
<b>Appendix D</b>	<b>Table 1: Integration Formulas . . . . .</b>	<b>935</b>
	<b>Answers . . . . .</b>	<b>A-1</b>
	<b>Index . . . . .</b>	<b>I-1</b>
	<b>Index of Applications . . . . .</b>	<b>I-10</b>