

Contents

P	▷ Preparation for Calculus	1
P.1	Graphs and Models	2
P.2	Linear Models and Rates of Change	10
P.3	Functions and Their Graphs	19
P.4	Fitting Models to Data	31
	Review Exercises	37
	P.S. Problem Solving	39
1	▷ Limits and Their Properties	41
1.1	A Preview of Calculus	42
1.2	Finding Limits Graphically and Numerically	48
1.3	Evaluating Limits Analytically	59
1.4	Continuity and One-Sided Limits	70
1.5	Infinite Limits	83
	Section Project: Graphs and Limits of Trigonometric Functions	90
	Review Exercises	91
	P.S. Problem Solving	93
2	▷ Differentiation	95
2.1	The Derivative and the Tangent Line Problem	96
2.2	Basic Differentiation Rules and Rates of Change	106
2.3	Product and Quotient Rules and Higher-Order Derivatives	118
2.4	The Chain Rule	129
2.5	Implicit Differentiation	140
	Section Project: Optical Illusions	147
2.6	Related Rates	148
	Review Exercises	157
	P.S. Problem Solving	159
3	▷ Applications of Differentiation	161
3.1	Extrema on an Interval	162
3.2	Rolle's Theorem and the Mean Value Theorem	170
3.3	Increasing and Decreasing Functions and the First Derivative Test	177
	Section Project: Rainbows	186
3.4	Concavity and the Second Derivative Test	187
3.5	Limits at Infinity	195
3.6	A Summary of Curve Sketching	206
3.7	Optimization Problems	215
	Section Project: Connecticut River	224
3.8	Newton's Method	225
3.9	Differentials	231
	Review Exercises	238
	P.S. Problem Solving	241

4	▷	Integration	243
4.1		Antiderivatives and Indefinite Integration	244
4.2		Area	254
4.3		Riemann Sums and Definite Integrals	266
4.4		The Fundamental Theorem of Calculus	277
		Section Project: Demonstrating the Fundamental Theorem	291
4.5		Integration by Substitution	292
4.6		Numerical Integration	305
		Review Exercises	312
		P.S. Problem Solving	315
5	▷	Logarithmic, Exponential, and Other Transcendental Functions	317
5.1		The Natural Logarithmic Function: Differentiation	318
5.2		The Natural Logarithmic Function: Integration	328
5.3		Inverse Functions	337
5.4		Exponential Functions: Differentiation and Integration	346
5.5		Bases Other than e and Applications	356
		Section Project: Using Graphing Utilities to Estimate Slope	365
5.6		Inverse Trigonometric Functions: Differentiation	366
5.7		Inverse Trigonometric Functions: Integration	375
5.8		Hyperbolic Functions	383
		Section Project: St. Louis Arch	392
		Review Exercises	393
		P.S. Problem Solving	395
6	▷	Differential Equations	397
6.1		Slope Fields and Euler's Method	398
6.2		Differential Equations: Growth and Decay	407
6.3		Separation of Variables and the Logistic Equation	415
6.4		First-Order Linear Differential Equations	424
		Section Project: Weight Loss	430
		Review Exercises	431
		P.S. Problem Solving	433
7	▷	Applications of Integration	435
7.1		Area of a Region Between Two Curves	436
7.2		Volume: The Disk Method	446
7.3		Volume: The Shell Method	457
		Section Project: Saturn	465
7.4		Arc Length and Surfaces of Revolution	466
7.5		Work	477
		Section Project: Tidal Energy	485
7.6		Moments, Centers of Mass, and Centroids	486
7.7		Fluid Pressure and Fluid Force	497
		Review Exercises	503
		P.S. Problem Solving	505

8 ▷ **Integration Techniques, L'Hopital's Rule, and Improper Integrals** 507

- 8.1 Basic Integration Rules 508
- 8.2 Integration by Parts 515
- 8.3 Trigonometric Integrals 524
 - Section Project: Power Lines** 532
- 8.4 Trigonometric Substitution 533
- 8.5 Partial Fractions 542
- 8.6 Integration by Tables and Other Integration Techniques 551
- 8.7 Indeterminate Forms and L'Hopital's Rule 557
- 8.8 Improper Integrals 568
 - Review Exercises** 579
 - P.S. Problem Solving** 581

9 ▷ **Infinite Series** 583

- 9.1 Sequences 584
- 9.2 Series and Convergence 595
 - Section Project: Cantor's Disappearing Table** 604
- 9.3 The Integral Test and p -Series 605
 - Section Project: The Harmonic Series** 611
- 9.4 Comparisons of Series 612
 - Section Project: Solera Method** 618
- 9.5 Alternating Series 619
- 9.6 The Ratio and Root Tests 627
- 9.7 Taylor Polynomials and Approximations 636
- 9.8 Power Series 647
- 9.9 Representation of Functions by Power Series 657
- 9.10 Taylor and Maclaurin Series 664
 - Review Exercises** 676
 - P.S. Problem Solving** 679

10 ▷ **Conics, Parametric Equations, and Polar Coordinates** 681

- 10.1 Conics and Calculus 682
- 10.2 Plane Curves and Parametric Equations 696
 - Section Project: Cycloids** 705
- 10.3 Parametric Equations and Calculus 706
- 10.4 Polar Coordinates and Polar Graphs 715
 - Section Project: Anamorphic Art** 724
- 10.5 Area and Arc Length in Polar Coordinates 725
- 10.6 Polar Equations of Conics and Kepler's Laws 734
 - Review Exercises** 742
 - P.S. Problem Solving** 745

11	▷ Vectors and the Geometry of Space	747
11.1	Vectors in the Plane	748
11.2	Space Coordinates and Vectors in Space	758
11.3	The Dot Product of Two Vectors	766
11.4	The Cross Product of Two Vectors in Space	775
11.5	Lines and Planes in Space	783
	Section Project: Distances in Space	793
11.6	Surfaces in Space	794
11.7	Cylindrical and Spherical Coordinates	804
	Review Exercises	811
	P.S. Problem Solving	813
12	▷ Vector-Valued Functions	815
12.1	Vector-Valued Functions	816
	Section Project: Witch of Agnesi	823
12.2	Differentiation and Integration of Vector-Valued Functions	824
12.3	Velocity and Acceleration	832
12.4	Tangent Vectors and Normal Vectors	841
12.5	Arc Length and Curvature	851
	Review Exercises	863
	P.S. Problem Solving	865
13	▷ Functions of Several Variables	867
13.1	Introduction to Functions of Several Variables	868
13.2	Limits and Continuity	880
13.3	Partial Derivatives	890
	Section Project: Moiré Fringes	899
13.4	Differentials	900
13.5	Chain Rules for Functions of Several Variables	907
13.6	Directional Derivatives and Gradients	915
13.7	Tangent Planes and Normal Lines	927
	Section Project: Wildflowers	935
13.8	Extrema of Functions of Two Variables	936
13.9	Applications of Extrema	944
	Section Project: Building a Pipeline	951
13.10	Lagrange Multipliers	952
	Review Exercises	960
	P.S. Problem Solving	963

14 ▷ Multiple Integration

965

- 14.1 Iterated Integrals and Area in the Plane 966
- 14.2 Double Integrals and Volume 974
- 14.3 Change of Variables: Polar Coordinates 986
- 14.4 Center of Mass and Moments of Inertia 994
- Section Project: Center of Pressure on a Sail** 1001
- 14.5 Surface Area 1002
- Section Project: Capillary Action** 1008
- 14.6 Triple Integrals and Applications 1009
- 14.7 Triple Integrals in Other Coordinates 1020
- Section Project: Wrinkled and Bumpy Spheres** 1026
- 14.8 Change of Variables: Jacobians 1027
- Review Exercises** 1034
- P.S. Problem Solving** 1037

15 ▷ Vector Analysis

1039

- 15.1 Vector Fields 1040
- 15.2 Line Integrals 1051
- 15.3 Conservative Vector Fields and Independence of Path 1065
- 15.4 Green's Theorem 1075
- Section Project: Hyperbolic and Trigonometric Functions** 1083
- 15.5 Parametric Surfaces 1084
- 15.6 Surface Integrals 1094
- Section Project: Hyperboloid of One Sheet** 1105
- 15.7 Divergence Theorem 1106
- 15.8 Stokes's Theorem 1114
- Review Exercises** 1120
- Section Project: The Planimeter** 1122
- P.S. Problem Solving** 1123

Appendices

Appendix A: Proofs of Selected Theorems A2

Appendix B: Integration Tables A3

Appendix C: Precalculus Review (Web)*

- C.1 Real Numbers and the Real Number Line
- C.2 The Cartesian Plane
- C.3 Review of Trigonometric Functions

Appendix D: Rotation and the General Second-Degree Equation (Web)*

Appendix E: Complex Numbers (Web)*

Appendix F: Business and Economic Applications (Web)*

Answers to All Odd-Numbered Exercises and Tests A7

Index A115

*Available at the text-specific website www.cengagebrain.com