



CONTENTS

0**BEFORE CALCULUS 1**

- 0.1 Functions 1
- 0.2 New Functions from Old 15
- 0.3 Families of Functions 27
- 0.4 Inverse Functions; Inverse Trigonometric Functions 38
- 0.5 Exponential and Logarithmic Functions 52

1**LIMITS AND CONTINUITY 67**

- 1.1 Limits (An Intuitive Approach) 67
- 1.2 Computing Limits 80
- 1.3 Limits at Infinity; End Behavior of a Function 89
- 1.4 Limits (Discussed More Rigorously) 100
- 1.5 Continuity 110
- 1.6 Continuity of Trigonometric, Exponential, and Inverse Functions 121

2**THE DERIVATIVE 131**

- 2.1 Tangent Lines and Rates of Change 131
- 2.2 The Derivative Function 143
- 2.3 Introduction to Techniques of Differentiation 155
- 2.4 The Product and Quotient Rules 163
- 2.5 Derivatives of Trigonometric Functions 169
- 2.6 The Chain Rule 174

3**TOPICS IN DIFFERENTIATION 185**

- 3.1 Implicit Differentiation 185
- 3.2 Derivatives of Logarithmic Functions 192
- 3.3 Derivatives of Exponential and Inverse Trigonometric Functions 197
- 3.4 Related Rates 204
- 3.5 Local Linear Approximation; Differentials 212
- 3.6 L'Hôpital's Rule; Indeterminate Forms 219

4 THE DERIVATIVE IN GRAPHING AND APPLICATIONS 232

- 4.1 Analysis of Functions I: Increase, Decrease, and Concavity 232
- 4.2 Analysis of Functions II: Relative Extrema; Graphing Polynomials 244
- 4.3 Analysis of Functions III: Rational Functions, Cusps, and Vertical Tangents 254
- 4.4 Absolute Maxima and Minima 266
- 4.5 Applied Maximum and Minimum Problems 274
- 4.6 Rectilinear Motion 288
- 4.7 Newton's Method 296
- 4.8 Rolle's Theorem; Mean-Value Theorem 302

5 INTEGRATION 316

- 5.1 An Overview of the Area Problem 316
- 5.2 The Indefinite Integral 322
- 5.3 Integration by Substitution 332
- 5.4 The Definition of Area as a Limit; Sigma Notation 340
- 5.5 The Definite Integral 353
- 5.6 The Fundamental Theorem of Calculus 362
- 5.7 Rectilinear Motion Revisited Using Integration 376
- 5.8 Average Value of a Function and Its Applications 385
- 5.9 Evaluating Definite Integrals by Substitution 390
- 5.10 Logarithmic and Other Functions Defined by Integrals 396

6 APPLICATIONS OF THE DEFINITE INTEGRAL IN GEOMETRY, SCIENCE, AND ENGINEERING 413

- 6.1 Area Between Two Curves 413
- 6.2 Volumes by Slicing; Disks and Washers 421
- 6.3 Volumes by Cylindrical Shells 432
- 6.4 Length of a Plane Curve 438
- 6.5 Area of a Surface of Revolution 444
- 6.6 Work 449
- 6.7 Moments, Centers of Gravity, and Centroids 458
- 6.8 Fluid Pressure and Force 467
- 6.9 Hyperbolic Functions and Hanging Cables 474

7 PRINCIPLES OF INTEGRAL EVALUATION 488

- 7.1 An Overview of Integration Methods 488
- 7.2 Integration by Parts 491
- 7.3 Integrating Trigonometric Functions 500
- 7.4 Trigonometric Substitutions 508
- 7.5 Integrating Rational Functions by Partial Fractions 514
- 7.6 Using Computer Algebra Systems and Tables of Integrals 523

- 7.7 Numerical Integration; Simpson's Rule 533
- 7.8 Improper Integrals 547

8 MATHEMATICAL MODELING WITH DIFFERENTIAL EQUATIONS 561

- 8.1 Modeling with Differential Equations 561
- 8.2 Separation of Variables 568
- 8.3 Slope Fields; Euler's Method 579
- 8.4 First-Order Differential Equations and Applications 586

9 INFINITE SERIES 596

- 9.1 Sequences 596
- 9.2 Monotone Sequences 607
- 9.3 Infinite Series 614
- 9.4 Convergence Tests 623
- 9.5 The Comparison, Ratio, and Root Tests 631
- 9.6 Alternating Series; Absolute and Conditional Convergence 638
- 9.7 Maclaurin and Taylor Polynomials 648
- 9.8 Maclaurin and Taylor Series; Power Series 659
- 9.9 Convergence of Taylor Series 668
- 9.10 Differentiating and Integrating Power Series; Modeling with Taylor Series 678

10 PARAMETRIC AND POLAR CURVES; CONIC SECTIONS 692

- 10.1 Parametric Equations; Tangent Lines and Arc Length for Parametric Curves 692
- 10.2 Polar Coordinates 705
- 10.3 Tangent Lines, Arc Length, and Area for Polar Curves 719
- 10.4 Conic Sections 730
- 10.5 Rotation of Axes; Second-Degree Equations 748
- 10.6 Conic Sections in Polar Coordinates 754

11 THREE-DIMENSIONAL SPACE; VECTORS 767

- 11.1 Rectangular Coordinates in 3-Space; Spheres; Cylindrical Surfaces 767
- 11.2 Vectors 773
- 11.3 Dot Product; Projections 785
- 11.4 Cross Product 795
- 11.5 Parametric Equations of Lines 805
- 11.6 Planes in 3-Space 813
- 11.7 Quadric Surfaces 821
- 11.8 Cylindrical and Spherical Coordinates 832

12 VECTOR-VALUED FUNCTIONS 841

- 12.1 Introduction to Vector-Valued Functions 841
- 12.2 Calculus of Vector-Valued Functions 848
- 12.3 Change of Parameter; Arc Length 858
- 12.4 Unit Tangent, Normal, and Binormal Vectors 868
- 12.5 Curvature 873
- 12.6 Motion Along a Curve 882
- 12.7 Kepler's Laws of Planetary Motion 895

13 PARTIAL DERIVATIVES 906

- 13.1 Functions of Two or More Variables 906
- 13.2 Limits and Continuity 917
- 13.3 Partial Derivatives 927
- 13.4 Differentiability, Differentials, and Local Linearity 940
- 13.5 The Chain Rule 949
- 13.6 Directional Derivatives and Gradients 960
- 13.7 Tangent Planes and Normal Vectors 971
- 13.8 Maxima and Minima of Functions of Two Variables 977
- 13.9 Lagrange Multipliers 989

14 MULTIPLE INTEGRALS 1000

- 14.1 Double Integrals 1000
- 14.2 Double Integrals over Nonrectangular Regions 1009
- 14.3 Double Integrals in Polar Coordinates 1018
- 14.4 Surface Area; Parametric Surfaces 1026
- 14.5 Triple Integrals 1039
- 14.6 Triple Integrals in Cylindrical and Spherical Coordinates 1048
- 14.7 Change of Variables in Multiple Integrals; Jacobians 1058
- 14.8 Centers of Gravity Using Multiple Integrals 1071

15 TOPICS IN VECTOR CALCULUS 1084

- 15.1 Vector Fields 1084
- 15.2 Line Integrals 1094
- 15.3 Independence of Path; Conservative Vector Fields 1111
- 15.4 Green's Theorem 1122
- 15.5 Surface Integrals 1130
- 15.6 Applications of Surface Integrals; Flux 1138
- 15.7 The Divergence Theorem 1148
- 15.8 Stokes' Theorem 1158