

# Calculus Early Transcendentals, 10th Edition International Student Version

[Howard Anton](#), [Irl C. Bivens](#), [Stephen Davis](#)

## **TABLE OF 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** **TABLE OF 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
<b>10</b>	<b>PARAMETRIC AND POLAR CURVES; CONIC SECTIONS</b>	<b>692</b>
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
<b>11</b>	<b>THREE-DIMENSIONAL SPACE; VECTORS</b>	<b>767</b>
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
<b>12</b>	<b>VECTOR-VALUED FUNCTIONS</b>	<b>841</b>
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

<b>12.6</b>	<b>Motion Along a Curve</b>	<b>882</b>
<b>12.7</b>	<b>Kepler's Laws of Planetary Motion</b>	<b>895</b>
<b>13</b>	<b>PARTIAL DERIVATIVES</b>	<b>906</b>
<b>13.1</b>	<b>Functions of Two or More Variables</b>	<b>906</b>
<b>13.2</b>	<b>Limits and Continuity</b>	<b>917</b>
<b>13.3</b>	<b>Partial Derivatives</b>	<b>927</b>
<b>13.4</b>	<b>Differentiability, Differentials, and Local Linearity</b>	<b>940</b>
<b>13.5</b>	<b>The Chain Rule</b>	<b>949</b>
<b>13.6</b>	<b>Directional Derivatives and Gradients</b>	<b>960</b>
<b>13.7</b>	<b>Tangent Planes and Normal Vectors</b>	<b>971</b>
<b>13.8</b>	<b>Maxima and Minima of Functions of Two Variables</b>	<b>977</b>
<b>13.9</b>	<b>Lagrange Multipliers</b>	<b>989</b>
<b>14</b>	<b>MULTIPLE INTEGRALS</b>	<b>1000</b>
<b>14.1</b>	<b>Double Integrals</b>	<b>1000</b>
<b>14.2</b>	<b>Double Integrals over Nonrectangular Regions</b>	<b>1009</b>
<b>14.3</b>	<b>Double Integrals in Polar Coordinates</b>	<b>1018</b>
<b>14.4</b>	<b>Surface Area; Parametric Surfaces</b>	<b>1026</b>
<b>14.5</b>	<b>Triple Integrals</b>	<b>1039</b>
<b>14.6</b>	<b>Triple Integrals in Cylindrical and Spherical Coordinates</b>	<b>1048</b>
<b>14.7</b>	<b>Change of Variables in Multiple Integrals; Jacobians</b>	<b>1058</b>
<b>14.8</b>	<b>Centers of Gravity Using Multiple Integrals</b>	<b>1071</b>
<b>15</b>	<b>TOPICS IN VECTOR CALCULUS</b>	<b>1084</b>
<b>15.1</b>	<b>Vector Fields</b>	<b>1084</b>
<b>15.2</b>	<b>Line Integrals</b>	<b>1094</b>
<b>15.3</b>	<b>Independence of Path; Conservative Vector Fields</b>	<b>1111</b>
<b>15.4</b>	<b>Green's Theorem</b>	<b>1122</b>
<b>15.5</b>	<b>Surface Integrals</b>	<b>1130</b>

**15.6 Applications of Surface Integrals; Flux 1138**

**15.7 The Divergence Theorem 1148**

**15.8 Stokes' Theorem 1158**

## **A APPENDICES**

**A GRAPHING FUNCTIONS USING CALCULATORS AND COMPUTER ALGEBRA SYSTEMS A1**

**B TRIGONOMETRY REVIEW A13**

**C SOLVING POLYNOMIAL EQUATIONS A27**

**D SELECTED PROOFS A34**

**ANSWERS TO ODD-NUMBERED EXERCISES A45**

**INDEX I-1**

## **WEB APPENDICES (online only)**

**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**



<b>8.4</b>	<b>First-Order Differential Equations and Applications</b>	<b>586</b>
<b>9</b>	<b>INFINITE SERIES</b>	<b>596</b>
<b>9.1</b>	<b>Sequences</b>	<b>596</b>
<b>9.2</b>	<b>Monotone Sequences</b>	<b>607</b>
<b>9.3</b>	<b>Infinite Series</b>	<b>614</b>
<b>9.4</b>	<b>Convergence Tests</b>	<b>623</b>
<b>9.5</b>	<b>The Comparison, Ratio, and Root Tests</b>	<b>631</b>
<b>9.6</b>	<b>Alternating Series; Absolute and Conditional Convergence</b>	<b>638</b>
<b>9.7</b>	<b>Maclaurin and Taylor Polynomials</b>	<b>648</b>
<b>9.8</b>	<b>Maclaurin and Taylor Series; Power Series</b>	<b>659</b>
<b>9.9</b>	<b>Convergence of Taylor Series</b>	<b>668</b>
<b>9.10</b>	<b>Differentiating and Integrating Power Series; Modeling with Taylor Series</b>	<b>678</b>
<b>10</b>	<b>PARAMETRIC AND POLAR CURVES; CONIC SECTIONS</b>	<b>692</b>
<b>10.1</b>	<b>Parametric Equations; Tangent Lines and Arc Length for Parametric Curves</b>	<b>692</b>
<b>10.2</b>	<b>Polar Coordinates</b>	<b>705</b>
<b>10.3</b>	<b>Tangent Lines, Arc Length, and Area for Polar Curves</b>	<b>719</b>
<b>10.4</b>	<b>Conic Sections</b>	<b>730</b>
<b>10.5</b>	<b>Rotation of Axes; Second-Degree Equations</b>	<b>748</b>
<b>10.6</b>	<b>Conic Sections in Polar Coordinates</b>	<b>754</b>
<b>11</b>	<b>THREE-DIMENSIONAL SPACE; VECTORS</b>	<b>767</b>
<b>11.1</b>	<b>Rectangular Coordinates in 3-Space; Spheres; Cylindrical Surfaces</b>	<b>767</b>
<b>11.2</b>	<b>Vectors</b>	<b>773</b>
<b>11.3</b>	<b>Dot Product; Projections</b>	<b>785</b>
<b>11.4</b>	<b>Cross Product</b>	<b>795</b>
<b>11.5</b>	<b>Parametric Equations of Lines</b>	<b>805</b>
<b>11.6</b>	<b>Planes in 3-Space</b>	<b>813</b>
<b>11.7</b>	<b>Quadric Surfaces</b>	<b>821</b>

11.8	Cylindrical and Spherical Coordinates	832
<b>12</b>	<b>VECTOR-VALUED FUNCTIONS</b>	<b>841</b>
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
<b>13</b>	<b>PARTIAL DERIVATIVES</b>	<b>906</b>
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
<b>14</b>	<b>MULTIPLE INTEGRALS</b>	<b>1000</b>
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**

**A APPENDICES**

**A GRAPHING FUNCTIONS USING CALCULATORS AND COMPUTER ALGEBRA SYSTEMS A1**

**B TRIGONOMETRY REVIEW A13**

**C SOLVING POLYNOMIAL EQUATIONS A27**

**D SELECTED PROOFS A34**

**ANSWERS TO ODD-NUMBERED EXERCISES A45**

**INDEX I-1**

**WEB APPENDICES (online only)**