

FINNEY • THOMAS



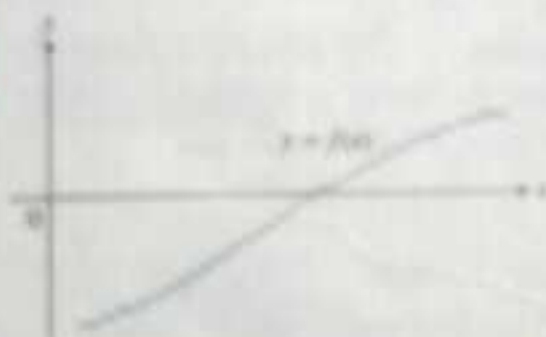
CALCULUS

SECOND EDITION

Contents

1

Prerequisites for Calculus

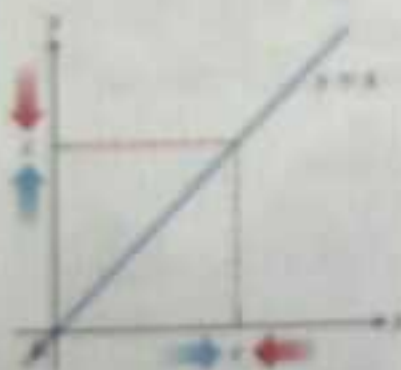


CHAPTER 1

1.1	Coordinates, Increments, and Lines	1
1.2	Functions and Graphs	11
1.3	Trigonometric Functions	22
1.4	Shifts, Circles, and Parabolas	30
1.5	Calculus and Computation	41
1.6	Absolute Values (Magnitudes) and Target Values	48
	<i>For Your Review</i>	58
	<i>Practice Exercises</i>	58

2

Limits and Continuity

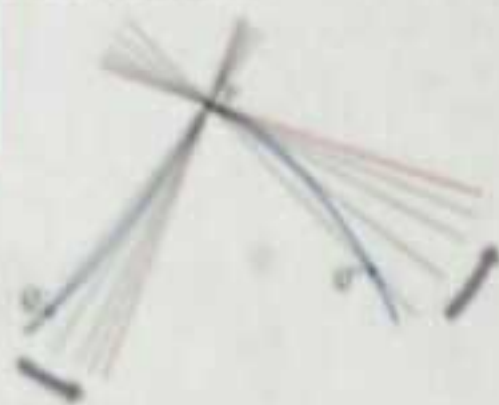


CHAPTER 2

2.1	Limits of Function Values	63
2.2	Limits Involving Infinity	76
2.3	The Sandwich Theorem and $(\sin \theta)/\theta$	84
2.4	Continuous Functions	90
2.5	Defining Limits Formally with Epsilon and Delta	101
	<i>For Your Review</i>	109
	<i>Practice Exercises</i>	109

3

Derivatives



OVERVIEW III

3.1	Slopes, Tangent Lines, and Derivatives	113
3.2	Differentiation Rules	126
3.3	Velocity, Speed, and Other Rates of Change	138
3.4	Derivatives of Trigonometric Functions	152
3.5	The Chain Rule	159
3.6	Implicit Differentiation and Fractional Powers	168
3.7	Linearizations and Differentials	176
3.8	Newton's Method	187
	<i>For Your Review</i>	195
	<i>Practice Exercises</i>	195

4

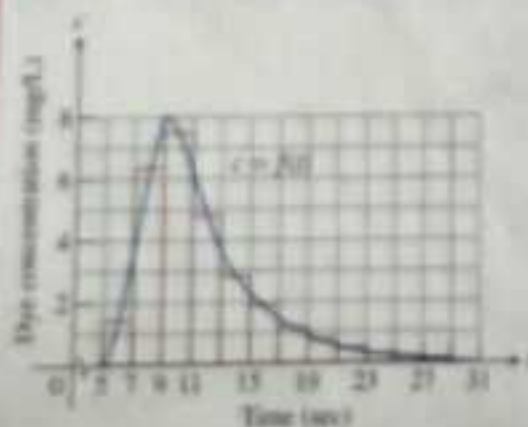
Applications of Derivatives

OVERVIEW III

4.1	Related Rates of Change	201
4.2	Extreme Values of Functions	209
4.3	How y' and y'' Determine the Shape of a Graph	218
4.4	Graphs of Rational Functions — Asymptotes and Dominant Terms	227
4.5	Optimization	234
4.6	The Mean Value Theorem	246
4.7	Antiderivatives, Differential Equations, and Modeling	253
	<i>For Your Review</i>	265
	<i>Practice Exercises</i>	266

5

Integration



OVERVIEW III

5.1	Estimating with Finite Sums	271
5.2	Riemann Sums and Definite Integrals	282
5.3	Basic Properties, Area, and the Mean Value Theorem for Integrals	294
5.4	The Fundamental Theorem of Calculus	302
5.5	Indefinite Integrals	313
5.6	Integration by Substitution — Running the Chain Rule Backward	322
5.7	Numerical Integration	331
	<i>For Your Review</i>	342
	<i>Practice Exercises</i>	342

6

Transcendental Functions

OVERVIEW 30

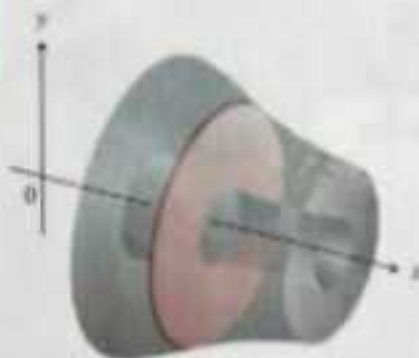
6.1	Exponential Functions and the Derivative of e^x	347
6.2	Inverse Functions and Their Derivatives	355
6.3	Logarithmic Functions and the Derivative of $\ln x$	361
6.4	Exponential and Logarithmic Integrals; $\ln x = \int_1^x \frac{1}{t} dt$	373
6.5	Growth and Decay	379
6.6	L'Hôpital's Rule	388
6.7	Relative Rates of Growth	395
6.8	Inverse Trigonometric Functions	401
6.9	Derivatives of Inverse Trigonometric Functions; Integrals	409
6.10	Hyperbolic Functions	416
6.11	First Order Differential Equations	424
	<i>For Your Review</i>	434
	<i>Practice Exercises</i>	435

7

Applications of Integration

OVERVIEW 39

7.1	Areas Between Curves	439
7.2	Volumes of Solids of Revolution — Disks and Washers	446
7.3	Cylindrical Shells — An Alternative to Washers	456
7.4	Curve Length and Surface Area	462
7.5	Work	472
7.6	Fluid Pressures and Fluid Forces	479
7.7	Centers of Mass	486
7.8	The Basic Pattern and Other Modeling Applications	497
	<i>For Your Review</i>	507
	<i>Practice Exercises</i>	507

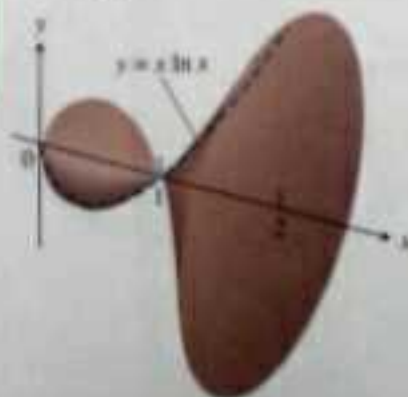


8

Techniques of Integration

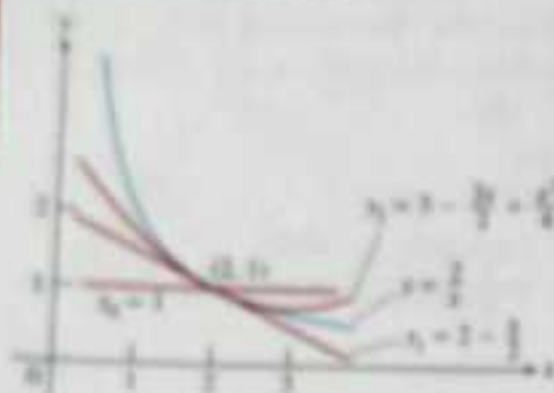
OVERVIEW 511

8.1	Basic Integration Formulas	511
8.2	Integration by Parts	517
8.3	Partial Fractions	524
8.4	Trigonometric Substitutions	529
8.5	Integral Tables	534
8.6	Improper Integrals	542
	<i>For Your Review</i>	552
	<i>Practice Exercises</i>	552



9

Infinite Series



OVERVIEW 587

9.1	Sequences	557
9.2	Infinite Series	567
9.3	Series with Nonnegative Terms—Comparison and Integral Tests	576
9.4	Series with Nonnegative Terms—Ratio and Root Tests	585
9.5	Alternating Series and Absolute Convergence	591
9.6	Power Series	597
9.7	Taylor and Maclaurin Series	605
9.8	Calculations with Taylor Series	619
	For Your Review	626
	Practice Exercises	626

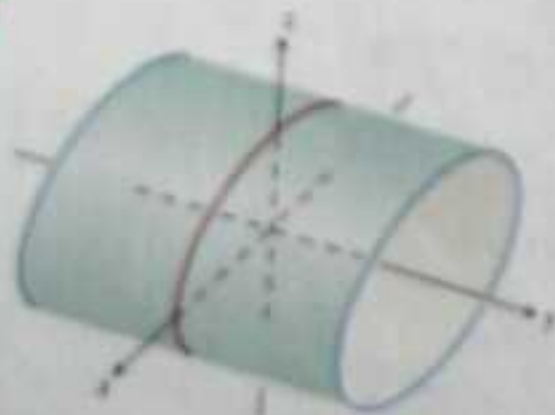
10

Conic Sections,
Parametrized
Curves, and Polar
Coordinates

OVERVIEW 629

10.1	Conic Sections and Quadratic Equations	629
10.2	The Graphs of Quadratic Equations in x and y ; Rotations About the Origin	645
10.3	Parametrizations of Curves	650
10.4	Calculus with Parametrized Curves	656
10.5	Polar Coordinates	662
10.6	Polar Graphs	667
10.7	Polar Equations for Conic Sections	674
10.8	Integration in Polar Coordinates	680
	For Your Review	686
	Practice Exercises	687

11

Vectors and
Analytic Geometry
in Space

OVERVIEW 691

11.1	Vectors in the Plane	691
11.2	Cartesian (Rectangular) Coordinates and Vectors in Space	700
11.3	Dot Products	710
11.4	Cross Products	718
11.5	Lines and Planes in Space	724
11.6	Surfaces in Space	731
11.7	Cylindrical and Spherical Coordinates	741
	For Your Review	746
	Practice Exercises	747

12

Vector-Valued Functions

OVERVIEW 751

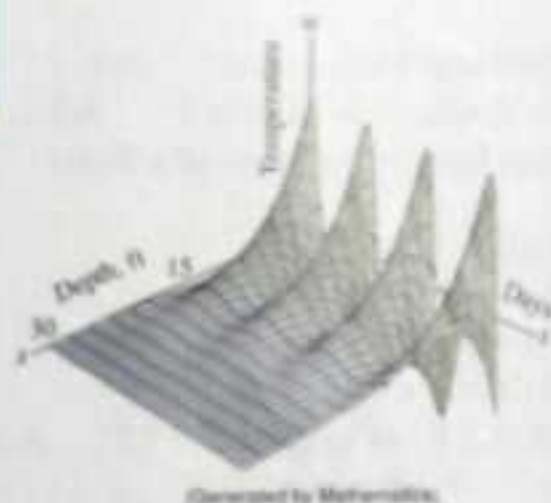
12.1	Vector-Valued Functions and Space Curves	751
12.2	Modeling Projectile Motion	762
12.3	Arc Length and the Unit Tangent Vector \mathbf{T}	771
12.4	Curvature, Torsion, and the TNB Frame	776
12.5	Planetary Motion and Satellites	788
	<i>For Your Review</i>	795
	<i>Practice Exercises</i>	795

13

Partial Derivatives

OVERVIEW 799

13.1	Functions of Several Independent Variables	799
13.2	Limits and Continuity	808
13.3	Partial Derivatives	814
13.4	Differentiability, Linearization, and Differentials	823
13.5	The Chain Rule	833
13.6	Directional Derivatives, Gradient Vectors, and Tangent Planes	841
13.7	Maxima, Minima, and Saddle Points	853
13.8	Lagrange Multipliers	864
	<i>For Your Review</i>	873
	<i>Practice Exercises</i>	873

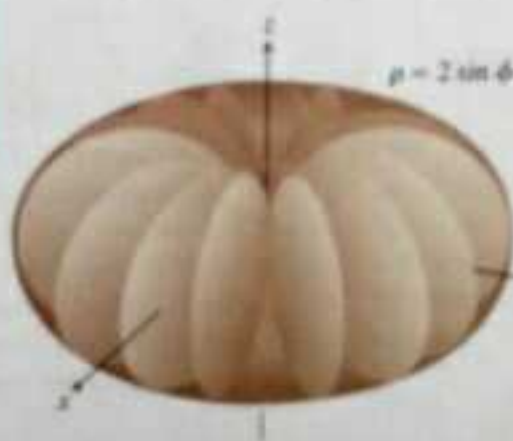


14

Multiple Integrals

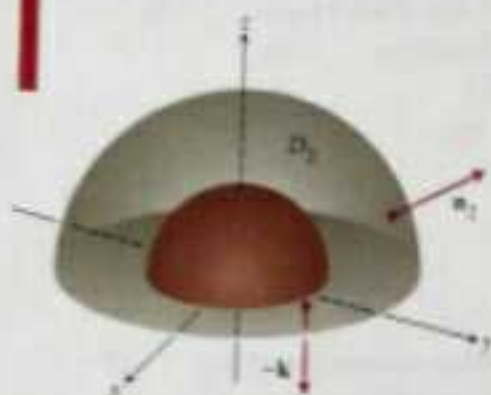
OVERVIEW 877

14.1	Double Integrals	877
14.2	Areas, Moments, and Centers of Mass	887
14.3	Double Integrals in Polar Form	893
14.4	Triple Integrals in Rectangular Coordinates	899
14.5	Masses and Moments in Three Dimensions	906
14.6	Triple Integrals in Cylindrical and Spherical Coordinates	910
14.7	Substitutions in Multiple Integrals	919
	<i>For Your Review</i>	927
	<i>Practice Exercises</i>	927



15

Integration in Vector Fields



Appendices

OVERVIEW 931

15.1	Line Integrals	931
15.2	Vector Fields, Work, Circulation, and Flux	937
15.3	Path Independence, Potential Functions, and Conservative Fields	946
15.4	Green's Theorem in the Plane	954
15.5	Surface Area and Surface Integrals	965
15.6	Parametrized Surfaces	975
15.7	Stokes's Theorem	983
15.8	The Divergence Theorem	993
	For Your Review	1001
	Practice Exercises	1001

A.1	Formulas from Precalculus Mathematics	A-1
A.2	Proofs of the Limit Theorems in Chapter 2	A-6
A.3	A Proof of the Chain Rule for Functions of a Single Variable	A-9
A.4	Mathematical Induction	A-10
A.5	Simpson's One-Third Rule	A-13
A.6	Limits That Arise Frequently	A-14
A.7	Determinants and Cramer's Rule	A-16
A.8	Path Independence of $\int \mathbf{F} \cdot d\mathbf{r}$ Implies $\mathbf{F} = \nabla f$	A-24
A.9	Complex Numbers	A-25
A.10	Tables for $\sin x$, $\cos x$, $\tan x$, e^x , e^{-x} , and $\ln x$	A-26

Answers A-29

Index I-1

A Brief Table of Integrals T-1