



This Edition is licensed for sale only in the Philippines. Circulation of this Edition outside of the Philippines is UNAUTHORIZED AND STRICTLY PROHIBITED.

Calculus

International Metric Version

Eighth Edition



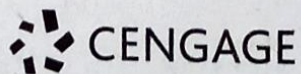
James Stewart

Calculus

International Metric Version

Eighth Edition

James Stewart



Australia • Brazil • Mexico • Singapore • United Kingdom • United States

© 2018 Cengage Learning Asia Pte Ltd

This edition is reprinted for sale in the Philippines only.

ALL RIGHTS RESERVED. No part of this work covered by the copyright herein may be reproduced, transmitted, stored or used in any form or by any means graphic, electronic, or mechanical, including but not limited to photocopying, recording, scanning, digitalizing, taping, Web distribution, information networks, or information storage and retrieval systems, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without the prior written permission of the publisher.

For product information and technology assistance, contact us at
Cengage Learning Philippines Customer Support, 632-869-9660

For permission to use material from this text or product, submit all
online requests online at www.cengageasia.com/permissions
Further permissions questions can be emailed to
asia.permissionrequest@cengage.com

ISBN:978-981-4773-87-4

Cengage Learning Asia Pte Ltd
151 Lorong Chuan
#02-08 New Tech Park
Singapore 556741

Cengage Learning Asia Pte Ltd (Philippines Branch)
Unit 1103, 11th Corporate Center
11th Avenue, corner Triangle Drive, North Bonifacio
Bonifacio Global City, Taguig City
Philippines 1634

Cengage Learning is a leading provider of customized learning solutions with office locations around the globe, including Singapore, the United Kingdom, Australia, Mexico, Brazil and Japan. Locate your local office at www.cengage.com/global

Cengage Learning products are represented in Canada by Nelson Education, Ltd.

Visit our website at www.cengageasia.com

Contents

PREFACE	xi
TO THE STUDENT	xxiii
CALCULATORS, COMPUTERS, AND OTHER GRAPHING DEVICES	xxiv
DIAGNOSTIC TESTS	xxvi

A Preview of Calculus 1

1

Functions and Limits

9



- 1.1 Four Ways to Represent a Function 10
- 1.2 Mathematical Models: A Catalog of Essential Functions 23
- 1.3 New Functions from Old Functions 36
- 1.4 The Tangent and Velocity Problems 45
- 1.5 The Limit of a Function 50
- 1.6 Calculating Limits Using the Limit Laws 62
- 1.7 The Precise Definition of a Limit 72
- 1.8 Continuity 82
- Review 94

Principles of Problem Solving 98

2

Derivatives

105



- 2.1 Derivatives and Rates of Change 106
 - Writing Project • Early Methods for Finding Tangents 117
- 2.2 The Derivative as a Function 117
- 2.3 Differentiation Formulas 130
 - Applied Project • Building a Better Roller Coaster 144
- 2.4 Derivatives of Trigonometric Functions 144
- 2.5 The Chain Rule 152
 - Applied Project • Where Should a Pilot Start Descent? 161
- 2.6 Implicit Differentiation 161
 - Laboratory Project • Families of Implicit Curves 168

- 2.7 Rates of Change in the Natural and Social Sciences 169
- 2.8 Related Rates 181
- 2.9 Linear Approximations and Differentials 188
 - Laboratory Project • Taylor Polynomials 194
- Review 195
- Problems Plus 200

3**Applications of Differentiation**

203



- 3.1 Maximum and Minimum Values 204
 - Applied Project • The Calculus of Rainbows 213
- 3.2 The Mean Value Theorem 215
- 3.3 How Derivatives Affect the Shape of a Graph 221
- 3.4 Limits at Infinity; Horizontal Asymptotes 231
- 3.5 Summary of Curve Sketching 244
- 3.6 Graphing with Calculus and Calculators 251
- 3.7 Optimization Problems 258
 - Applied Project • The Shape of a Can 270
 - Applied Project • Planes and Birds: Minimizing Energy 271
- 3.8 Newton's Method 272
- 3.9 Antiderivatives 278
 - Review 285
- Problems Plus 289

4**Integrals**

293

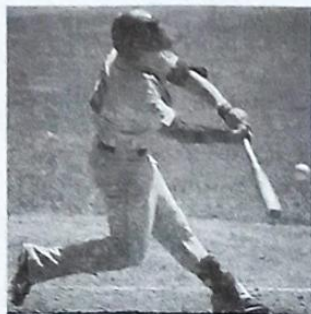


- 4.1 Areas and Distances 294
- 4.2 The Definite Integral 306
 - Discovery Project • Area Functions 319
- 4.3 The Fundamental Theorem of Calculus 320
- 4.4 Indefinite Integrals and the Net Change Theorem 330
 - Writing Project • Newton, Leibniz, and the Invention of Calculus 339
- 4.5 The Substitution Rule 340
 - Review 348
- Problems Plus 352

5

Applications of Integration

355



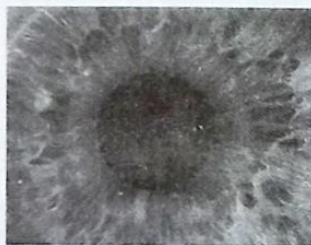
- 5.1** Areas Between Curves 356
Applied Project • The Gini Index 364
- 5.2** Volumes 366
- 5.3** Volumes by Cylindrical Shells 377
- 5.4** Work 383
- 5.5** Average Value of a Function 389
Applied Project • Calculus and Baseball 392
Review 393
- Problems Plus** 395

6

Inverse Functions:

399

Exponential, Logarithmic, and Inverse Trigonometric Functions



- 6.1** Inverse Functions 400

Instructors may cover either Sections 6.2–6.4 or Sections 6.2*–6.4*. See the Preface.

- | | |
|---|---|
| <ul style="list-style-type: none"> 6.2 Exponential Functions and Their Derivatives 408 6.3 Logarithmic Functions 421 6.4 Derivatives of Logarithmic Functions 428 | <ul style="list-style-type: none"> 6.2* The Natural Logarithmic Function 438 6.3* The Natural Exponential Function 447 6.4* General Logarithmic and Exponential Functions 455 |
|---|---|
- 6.5** Exponential Growth and Decay 466
Applied Project • Controlling Red Blood Cell Loss During Surgery 473
 - 6.6** Inverse Trigonometric Functions 474
Applied Project • Where to Sit at the Movies 483
 - 6.7** Hyperbolic Functions 484
 - 6.8** Indeterminate Forms and l'Hospital's Rule 491
Writing Project • The Origins of l'Hospital's Rule 503
Review 503
 - Problems Plus** 508

7 Techniques of Integration

511



- 7.1 Integration by Parts 512
- 7.2 Trigonometric Integrals 519
- 7.3 Trigonometric Substitution 526
- 7.4 Integration of Rational Functions by Partial Fractions 533
- 7.5 Strategy for Integration 543
- 7.6 Integration Using Tables and Computer Algebra Systems 548
 - Discovery Project • Patterns in Integrals 553
- 7.7 Approximate Integration 554
- 7.8 Improper Integrals 567
 - Review 577
- Problems Plus 580

8 Further Applications of Integration

583



- 8.1 Arc Length 584
 - Discovery Project • Arc Length Contest 590
- 8.2 Area of a Surface of Revolution 591
 - Discovery Project • Rotating on a Slant 597
- 8.3 Applications to Physics and Engineering 598
 - Discovery Project • Complementary Coffee Cups 608
- 8.4 Applications to Economics and Biology 609
- 8.5 Probability 613
 - Review 621
- Problems Plus 623

9 Differential Equations

625



- 9.1 Modeling with Differential Equations 626
- 9.2 Direction Fields and Euler's Method 631
- 9.3 Separable Equations 639
 - Applied Project • How Fast Does a Tank Drain? 648
 - Applied Project • Which Is Faster, Going Up or Coming Down? 649
- 9.4 Models for Population Growth 650
- 9.5 Linear Equations 660

9.6 Predator-Prey Systems 667

Review 674

Problems Plus 677

10**Parametric Equations and Polar Coordinates**

679

**10.1** Curves Defined by Parametric Equations 680

Laboratory Project • Running Circles Around Circles 688

10.2 Calculus with Parametric Curves 689

Laboratory Project • Bézier Curves 697

10.3 Polar Coordinates 698

Laboratory Project • Families of Polar Curves 708

10.4 Areas and Lengths in Polar Coordinates 709**10.5** Conic Sections 714**10.6** Conic Sections in Polar Coordinates 722

Review 729

Problems Plus 732

11**Infinite Sequences and Series**

733

**11.1** Sequences 734

Laboratory Project • Logistic Sequences 747

11.2 Series 747**11.3** The Integral Test and Estimates of Sums 759**11.4** The Comparison Tests 767**11.5** Alternating Series 772**11.6** Absolute Convergence and the Ratio and Root Tests 777**11.7** Strategy for Testing Series 784**11.8** Power Series 786**11.9** Representations of Functions as Power Series 792**11.10** Taylor and Maclaurin Series 799

Laboratory Project • An Elusive Limit 813

Writing Project • How Newton Discovered the Binomial Series 813

11.11 Applications of Taylor Polynomials 814

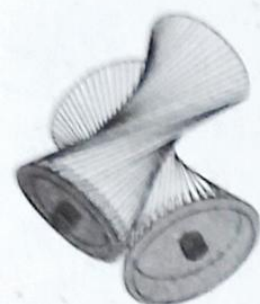
Applied Project • Radiation from the Stars 823

Review 824

Problems Plus 827

12**Vectors and the Geometry of Space**

831



- 12.1 Three-Dimensional Coordinate Systems 832
- 12.2 Vectors 838
- 12.3 The Dot Product 847
- 12.4 The Cross Product 854
 - Discovery Project • The Geometry of a Tetrahedron 863
- 12.5 Equations of Lines and Planes 863
 - Laboratory Project • Putting 3D in Perspective 873
- 12.6 Cylinders and Quadric Surfaces 874
 - Review 881
- Problems Plus 884

13**Vector Functions**

887



- 13.1 Vector Functions and Space Curves 888
- 13.2 Derivatives and Integrals of Vector Functions 895
- 13.3 Arc Length and Curvature 901
- 13.4 Motion in Space: Velocity and Acceleration 910
 - Applied Project • Kepler's Laws 920
- Review 921
- Problems Plus 924

14**Partial Derivatives**

927



- 14.1 Functions of Several Variables 928
- 14.2 Limits and Continuity 943
- 14.3 Partial Derivatives 951
- 14.4 Tangent Planes and Linear Approximations 967
 - Applied Project • The Speedo LZR Racer 976
- 14.5 The Chain Rule 977
- 14.6 Directional Derivatives and the Gradient Vector 986
- 14.7 Maximum and Minimum Values 999
 - Applied Project • Designing a Dumpster 1010
 - Discovery Project • Quadratic Approximations and Critical Points 1010

- 14.8** Lagrange Multipliers 1011
 Applied Project • Rocket Science 1019
 Applied Project • Hydro-Turbine Optimization 1020
 Review 1021
Problems Plus 1025

15 Multiple Integrals

1027



- 15.1** Double Integrals over Rectangles 1028
15.2 Double Integrals over General Regions 1041
15.3 Double Integrals in Polar Coordinates 1050
15.4 Applications of Double Integrals 1056
15.5 Surface Area 1066
15.6 Triple Integrals 1069
 Discovery Project • Volumes of Hyperspheres 1080
15.7 Triple Integrals in Cylindrical Coordinates 1080
 Discovery Project • The Intersection of Three Cylinders 1084
15.8 Triple Integrals in Spherical Coordinates 1085
 Applied Project • Roller Derby 1092
15.9 Change of Variables in Multiple Integrals 1092
 Review 1101
Problems Plus 1105

16 Vector Calculus

1107



- 16.1** Vector Fields 1108
16.2 Line Integrals 1115
16.3 The Fundamental Theorem for Line Integrals 1127
16.4 Green's Theorem 1136
16.5 Curl and Divergence 1143
16.6 Parametric Surfaces and Their Areas 1151
16.7 Surface Integrals 1162
16.8 Stokes' Theorem 1174
 Writing Project • Three Men and Two Theorems 1180

- 16.9 The Divergence Theorem 1181
- 16.10 Summary 1187
- Review 1188
- Problems Plus 1191

17 Second-Order Differential Equations

1193



- 17.1 Second-Order Linear Equations 1194
- 17.2 Nonhomogeneous Linear Equations 1200
- 17.3 Applications of Second-Order Differential Equations 1208
- 17.4 Series Solutions 1216
- Review 1221

Appendixes

A1

- A Numbers, Inequalities, and Absolute Values A2
- B Coordinate Geometry and Lines A10
- C Graphs of Second-Degree Equations A16
- D Trigonometry A24
- E Sigma Notation A34
- F Proofs of Theorems A39
- G Complex Numbers A48
- H Answers to Odd-Numbered Exercises A57

Index

A131

PHILIPPINE EDITION



C&E Publishing, Inc.
Towards Academic and Professional Excellence

839 EDSA South Triangle, Quezon City, Philippines
Tel No. (632) 929-5088 E-mail: info@cebookshop.com

www.cebookshop.com

This Edition is licensed for sale only
in the Philippines. Circulation of this
Edition outside of the Philippines is
UNAUTHORIZED AND STRICTLY
PROHIBITED.



For your lifelong learning solutions, visit www.cengage.com/custom
Visit our website at www.cengageasia.com

ISBN 978-981-4773-87-4

1 1111111111 1111111111

C & E BOOKSHOP



9 789814 773874 >

SCIENCE
MATHEMATICS

2018 - Cengage
Educational Media
Version 1.000