

海外优秀数学类教材系列丛书

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Calculus

影印版

For Business, Economics, Life Sciences,
and Social Sciences (Ninth Edition)

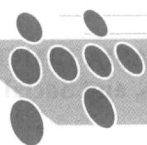
微积分

及其在商业、经济、生命科学
及社会科学中的应用
(第9版)

- ☐ RAYMOND A. BARNETT
- ☐ MICHAEL R. ZIEGLER
- ☐ KARL E. BYLEEN



高等教育出版社
Higher Education Press



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(第9版)

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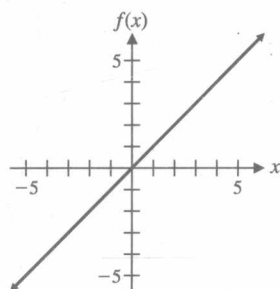
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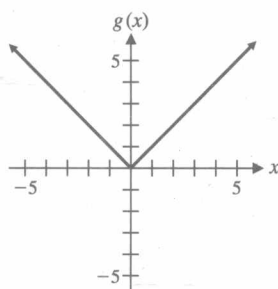
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A LIBRARY OF ELEMENTARY FUNCTIONS

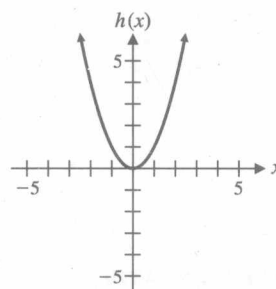
BASIC FUNCTIONS



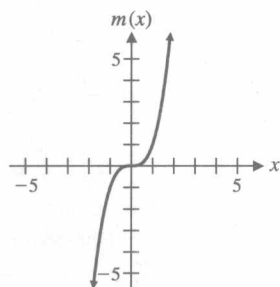
Identity function
 $f(x) = x$



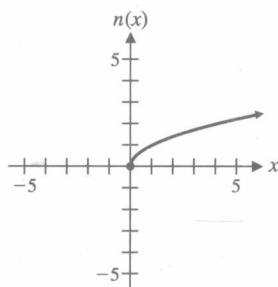
Absolute value function
 $g(x) = |x|$



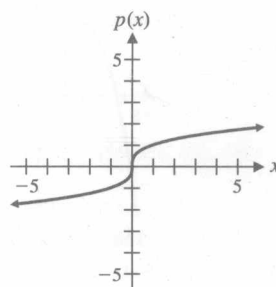
Square function
 $h(x) = x^2$



Cube function
 $m(x) = x^3$

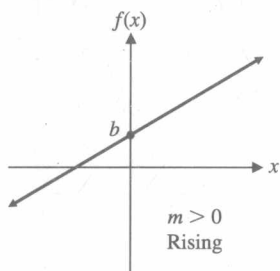


Square root function
 $n(x) = \sqrt{x}$

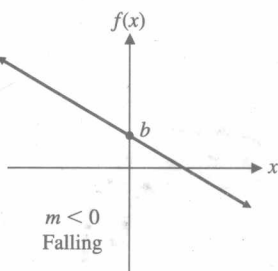


Cube root function
 $p(x) = \sqrt[3]{x}$

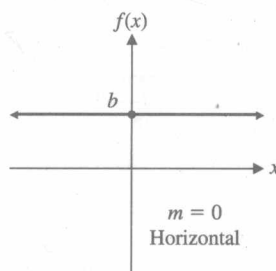
FIRST-DEGREE POLYNOMIAL FUNCTIONS



Linear function
 $f(x) = mx + b$

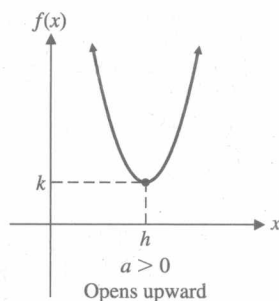


Linear function
 $f(x) = mx + b$

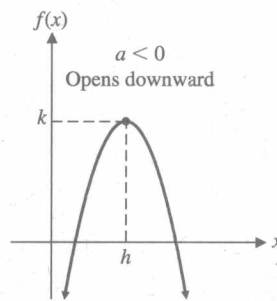


Constant function
 $f(x) = b$

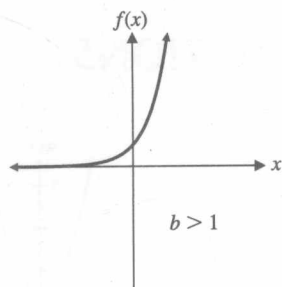
SECOND-DEGREE POLYNOMIAL FUNCTIONS



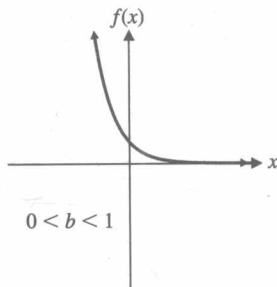
$$f(x) = ax^2 + bx + c = a(x - h)^2 + k$$



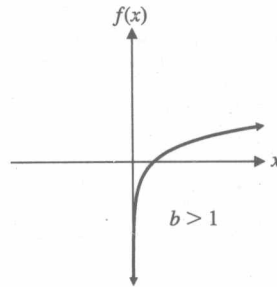
EXPONENTIAL AND LOGARITHMIC FUNCTIONS



Exponential function
 $f(x) = b^x$

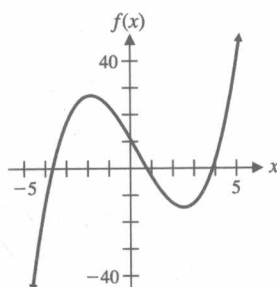


Exponential function
 $f(x) = b^x$

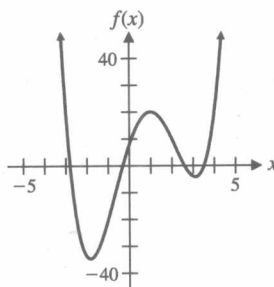


Logarithmic function
 $f(x) = \log_b x$

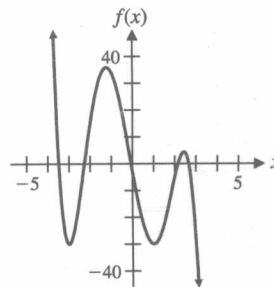
REPRESENTATIVE POLYNOMIAL FUNCTIONS (DEGREE > 2)



Third-degree polynomial
 $f(x) = x^3 - x^2 - 14x + 11$

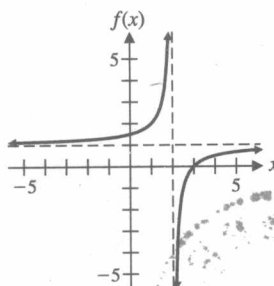


Fourth-degree polynomial
 $f(x) = x^4 - 3x^3 - 9x^2 + 23x + 8$

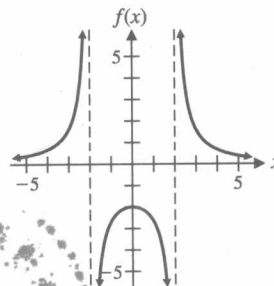


Fifth-degree polynomial
 $f(x) = -x^5 - x^4 + 14x^3 + 6x^2 - 45x - 3$

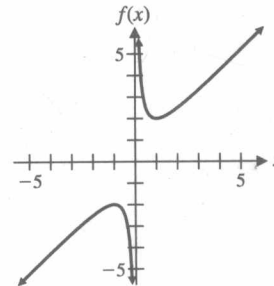
REPRESENTATIVE RATIONAL FUNCTIONS



$f(x) = \frac{x-3}{x-2}$

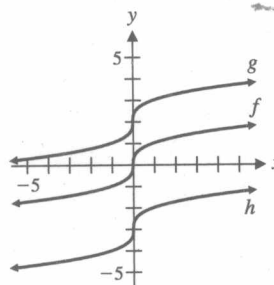


$f(x) = \frac{8}{x^2-4}$

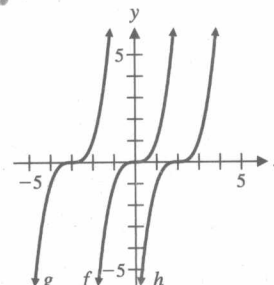


$f(x) = x + \frac{1}{x}$

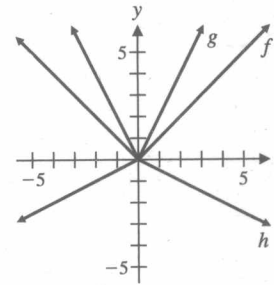
GRAPH TRANSFORMATIONS



Vertical translation
 $g(x) = f(x) + 2$
 $h(x) = f(x) - 3$



Horizontal translation
 $g(x) = f(x + 3)$
 $h(x) = f(x - 2)$



Expansion, contraction, and reflection
 $g(x) = 2f(x)$
 $h(x) = -0.5f(x)$

出版者的话

在我国已经加入 WTO、经济全球化的今天,为适应当前我国高校各类创新人才培养的需要,大力推进教育部倡导的双语教学,配合教育部实施的“高等学校教学质量与教学改革工程”和“精品课程”建设的需要,高等教育出版社有计划、大规模地开展了海外优秀数学类系列教材的引进工作。

高等教育出版社和 Pearson Education, John Wiley & Sons, McGraw-Hill, Thomson Learning 等国外出版公司进行了广泛接触,经国外出版公司的推荐并在国内专家的协助下,提交引进版权总数 100 余种。收到样书后,我们聘请了国内高校一线教师、专家、学者参与这些原版教材的评介工作,并参考国内相关专业的课程设置和教学实际情况,从中遴选出了这套优秀教材组织出版。

这批教材普遍具有以下特点:(1)基本上是近 3 年出版的,在国际上被广泛使用,在同类教材中具有相当的权威性;(2)高版次,历经多年教学实践检验,内容翔实准确、反映时代要求;(3)各种教学资源配套整齐,为师生提供了极大的便利;(4)插图精美、丰富,图文并茂,与正文相辅相成;(5)语言简练、流畅、可读性强,比较适合非英语国家的学生阅读。

本系列丛书中,有 Finney、Weir 等编的《托马斯微积分》(第 10 版, Pearson),其特色可用“呈传统特色、富革新精神”概括,本书自 20 世纪 50 年代第 1 版以来,平均每四五年就有一个新版面世,长达 50 余年始终盛行于西方教坛,作者既有相当高的学术水平,又热爱教学,长期工作在教学第一线,其中,年近 90 的 G. B. Thomas 教授长年在 MIT 工作,具有丰富的教学经验;Finney 教授也在 MIT 工作达 10 年;Weir 是美国数学建模竞赛委员会主任。Stewart 编的立体化教材《微积分》(第 5 版, Thomson Learning)配备了丰富的教学资源,是国际上最畅销的微积分原版教材,2003 年全球销量约 40 余万册,在美国,占据了约 50%~60% 的微积分教材市场,其用户包括耶鲁等名牌院校及众多一般院校。本系列丛书还包括 Anton 编的经典教材《线性代数及其应用》(第 8 版, Wiley); Jay L. Devore 编的优秀教材《概率论与数理统计》(第 5 版, Thomson Learning)等。在努力降低引进教材售价方面,高等教育出版社做了大量和细致的工作,这套引进的教材体现了一定的权威性、系统性、先进性和经济性等特点。

通过影印、翻译、编译这批优秀教材,我们一方面要不断地分析、学习、消化吸收国外优秀教材的长处,吸取国外出版公司的制作经验,提升我们自编教材的立体化配套标准,使我国高校教材建设水平上一个新的台阶;与此同时,我们还将尝试组织海外作者和国内作者合编外文版基础课数学教材,并约请国内专家改编部分国外优秀教材,以适应我国实际教学环境。

这套教材出版后,我们将结合各高校的双语教学计划,开展大规模的宣传、培训工作,及时地将本套丛书推荐给高校使用。在使用过程中,我们衷心希望广大高校教师和同学提出宝贵的意见和建议。

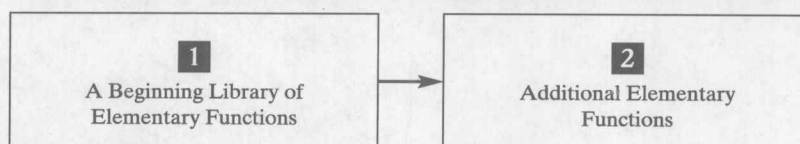
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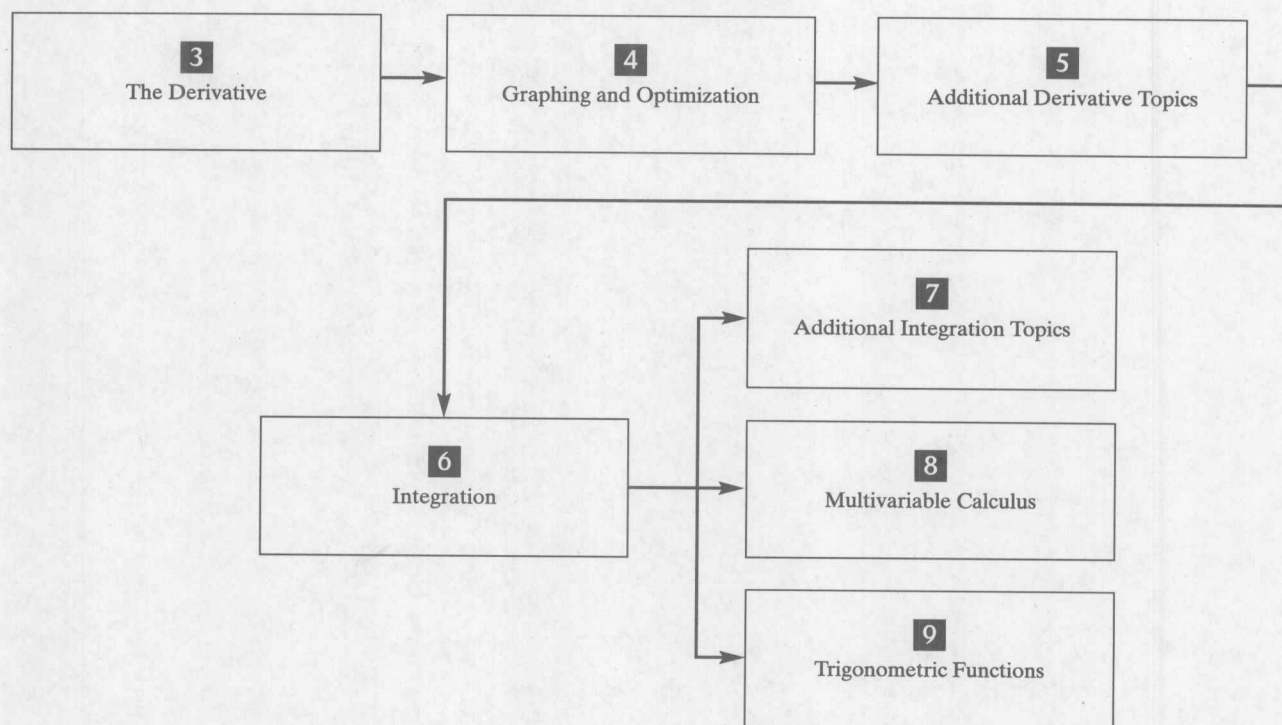
*Dedicated to Phyllis Niklas, whose expertise, diligence,
and patience helped make this series a success.*

Chapter Dependencies

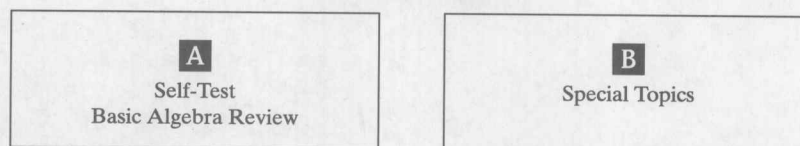
PART ONE A LIBRARY OF ELEMENTARY FUNCTIONS*



PART TWO CALCULUS



APPENDIXES



*Selected topics from Part One may be referred to as needed in Part Two or reviewed systematically before starting Part Two.

Preface

The ninth edition of *Calculus for Business, Economics, Life Sciences, and Social Sciences* is designed for a one-term course in calculus and for students who have had $1\frac{1}{2}$ –2 years of high school algebra or the equivalent. The choice and independence of topics make the text readily adaptable to a variety of courses (see the Chapter Dependency Chart on page xi). It is one of five books in the authors' college mathematics series.

Improvements in this edition evolved out of the generous response from a large number of users of the last and previous editions as well as survey results from instructors, mathematics departments, course outlines, and college catalogs. Fundamental to a book's growth and effectiveness is classroom use and feedback. Now in its ninth edition, *Calculus for Business, Economics, Life Sciences, and Social Sciences* has had the benefit of having a substantial amount of both.

■ Emphasis and Style

The text is **written for student comprehension**. Great care has been taken to write a book that is mathematically correct and accessible to students. Emphasis is on computational skills, ideas, and problem solving rather than mathematical theory. Most derivations and proofs are omitted except where their inclusion adds significant insight into a particular concept. General concepts and results are usually presented only after particular cases have been discussed.

■ Examples and Matched Problems

Over 290 completely worked examples are used to introduce concepts and to demonstrate problem-solving techniques. Many examples have multiple parts, significantly increasing the total number of worked examples. Each example is followed by a similar **matched problem for the student to work** while reading the material. This actively involves the student in the learning process. The answers to these matched problems are included at the end of each section for easy reference.

■ Exploration and Discussion



Every section contains **Explore–Discuss** problems interspersed at appropriate places to encourage the student to think about a relationship or process before a result is stated, or to investigate additional consequences of a development in the text. **Verbalization** of mathematical concepts, results, and processes is encouraged in these Explore–Discuss problems, as well as in some matched problems, and in some problems in almost every exercise set. The Explore–Discuss

material also can be used as in-class or out-of-class **group activities**. In addition, at the end of every chapter, we have included two special **chapter group activities** that involve several of the concepts discussed in the chapter. Problems in the exercise sets that require verbalization are indicated by color problem numbers.

■ Exercise Sets


The book contains over 4,100 problems. Many problems have multiple parts, significantly increasing the total number of problems. Each exercise set is designed so that an average or below-average student will experience success and a very capable student will be challenged. Exercise sets are mostly divided into A (routine, easy mechanics), B (more difficult mechanics), and C (difficult mechanics and some theory) levels.

■ Applications

A major objective of this book is to give the student substantial experience in **modeling and solving real-world problems**. Enough applications are included to convince even the most skeptical student that mathematics is really useful (see the Applications Index inside the back cover). Worked examples involving applications are identified by  or . **Almost every exercise set contains**



application problems, usually divided into business and economics, life science, and social science groupings. An instructor with students from all three disciplines can let them choose applications from their own field of interest; if most students are from one of the three areas, then special emphasis can be placed there. Most of the applications are simplified versions of actual real-world problems taken from professional journals and books. No specialized experience is required to solve any of the applications.

■ Internet Connections

The Internet provides a wealth of material that can be related to this book, from sources for the data in application problems to interactive exercises that provide additional insight into the various mathematical processes. Every section of the book contains Internet connections identified by . Links to the related web sites can be found at the **PH Companion Website** discussed later in this preface: www.prenhall.com/barnett.

■ Technology

The generic term **graphing utility** is used to refer to any of the various graphing calculators or computer software packages that might be available to a student using this book. (See the description of the software accompanying this book later in this Preface.) Although **access to a graphing utility is not assumed**, it is likely that many students will want to make use of one of these devices. To assist these students, **optional graphing utility activities** are included in appropriate places in the book. These include brief discussions in the text, examples or portions of examples solved on a graphing utility, problems for the student to solve, and a **group activity that involves the use of technology** at the end of each

chapter. Beginning with the group activity at the end of Chapter 1, and continuing throughout the text, **linear regression** on a graphing utility is used at appropriate points to illustrate **mathematical modeling with real data**. All the optional graphing utility material is clearly identified by either  or  and can be omitted without loss of continuity, if desired.

■ Graphs

All graphs are computer-generated to ensure mathematical accuracy. Graphing utility screens displayed in the text are actual output from a graphing calculator.

■ Additional Pedagogical Features

Annotation of examples and developments, in small color type, is found throughout the text to help students through critical stages (see Sections 1-1 and 3-2). **Think boxes** (dashed boxes) are used to enclose steps that are usually performed mentally (see Sections 1-1 and 3-4). **Boxes** are used to highlight important definitions, results, and step-by-step processes (see Sections 1-1 and 3-2). **Caution** statements appear throughout the text where student errors often occur (see Sections 3-2 and 4-1). **Functional use of color** improves the clarity of many illustrations, graphs, and developments, and guides students through certain critical steps (see Sections 1-1 and 3-2). **Boldface type** is used to introduce new terms and highlight important comments. **Chapter review** sections include a review of all important terms and symbols and a comprehensive review exercise. **Answers to most review exercises**, keyed to appropriate sections, are included in the back of the book. Answers to all other odd-numbered problems are also in the back of the book.

■ Content

The text begins with the development of a library of elementary functions in Chapters 1 and 2, including their properties and uses. We encourage students to investigate mathematical ideas and processes **graphically** and **numerically**, as well as **algebraically**. This development lays a firm foundation for studying mathematics both in this book and in future endeavors. Depending on the syllabus for the course and the background of the students, some or all of this material can be covered at the beginning of a course, or selected portions can be referred to as needed later in the course.

The material in Part Two (Calculus) consists of **differential calculus** (Chapters 3–5), **integral calculus** (Chapters 6–7), **multivariable calculus** (Chapter 8), and a brief discussion of differentiation and integration of **trigonometric functions** (Chapter 9). In general, Chapters 3–6 must be covered in sequence; however, certain sections can be omitted or given brief treatments, as pointed out in the discussion that follows (see the Chapter Dependency Chart on page xi).

Chapter 3 introduces the **derivative**, covers the **limit properties** essential to understanding the definition of the derivative, develops the **rules of differentiation** (including the chain rule for power forms), and introduces **applications** of derivatives in business and economics. The interplay between graphical, numerical, and algebraic concepts is emphasized here and throughout the text.

Chapter 4 focuses on **graphing** and **optimization**. The first three sections cover continuity and first-derivative and second-derivative graph properties, while emphasizing **polynomial graphing**. **Rational function** graphing is covered

in Section 4-4. In a course that does not include graphing rational functions, this section can be omitted or given a brief treatment. Optimization is covered in Section 4-5, including examples and problems involving end-point solutions.

The first three sections of Chapter 5 extend the derivative concepts discussed in Chapters 3 and 4 to **exponential and logarithmic functions** (including the general form of the chain rule). This material is required for all the remaining chapters. **Implicit differentiation** is introduced in Section 5-4 and applied to **related rate problems** in Section 5-5. These topics are not referred to elsewhere in the text and can be omitted.

Chapter 6 introduces **integration**. The first two sections cover **antidifferentiation** techniques essential to the remainder of the text. Section 6-3 discusses some applications involving **differential equations** that can be omitted. Sections 6-4 and 6-5 discuss the **definite integral** in terms of **Riemann sums**, including **approximations** with various types of sums and some **simple error estimation**. As before, the interplay between the graphical, numeric, and algebraic properties is emphasized. These two sections also are required for the remaining chapters in the text.

Chapter 7 covers **additional integration topics** and is organized to provide maximum flexibility for the instructor. The first section extends the **area** concepts introduced in Chapter 6 to the area between two curves and related applications. Section 7-2 covers three more **applications** of integration, and Sections 7-3 and 7-4 deal with additional **techniques of integration**. Any or all of the topics in Chapter 7 can be omitted.

The first five sections of Chapter 8 deal with **differential multivariable calculus** and can be covered any time after Section 5-3 has been completed. Section 8-6 requires the **integration** concepts discussed in Chapter 6.

Chapter 9 provides brief coverage of **trigonometric functions** that can be incorporated into the course, if desired. Section 9-1 provides a review of basic trigonometric concepts. Section 9-2 can be covered any time after Section 5-3 has been completed. Section 9-3 requires the material in Chapter 6.

Appendix A contains a **self-test** and a **concise review of basic algebra** that also may be covered as part of the course or referred to as needed. As mentioned above, Appendix B contains additional topics that can be covered in conjunction with certain sections in the text, if desired.

■ Supplements for the Student

1. A **Student Solutions Manual and Visual Calculus** by Garret J. Etgen and David Schneider is available through your book store. The manual includes detailed solutions to all odd-numbered problems and all review exercises. *Visual Calculus* by David Schneider contains over twenty routines that provide additional insight into the topics discussed in the text. Although this software has much of the computing power of standard calculus software packages, it is primarily a teaching tool that focuses on understanding mathematical concepts, rather than on computing. These routines incorporate graphics whenever possible to illustrate topics such as secant lines; tangent lines; velocity; optimization; the relationship between the graphs of f , f' , f'' ; and the various approaches to approximating definite integrals. All the routines in this software package are menu-driven and very easy to use. The software will run on DOS or Windows platforms.

2. The **PH Companion Website**, designed to complement and expand upon the text, offers a variety of teaching and learning tools, including links to related

websites, practice work for students, and the ability for instructors to monitor and evaluate students' work on the website. For more information, contact your local Prentice Hall representative.

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■ Supplements for the Instructor

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2. **A Test Item File**, prepared by Laurel Technical Services, provides a hard copy of the test items available in PH Custom Test.
3. **An Instructor's Solutions Manual** provides detailed solutions to the problems not solved in the Student Solutions Manual. This manual is available to instructors without charge.
4. **A Student Solutions Manual and Visual Calculus** by Garret J. Etgen and David Schneider (see Supplements for the Student) is available to instructors.
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■ Error Check

Because of the careful checking and proofing by a number of mathematics instructors (acting independently), the authors and publisher believe this book to be substantially error-free. For any errors remaining, the authors would be grateful if they were sent to: Karl E. Byleen, 9322 W. Garden Court, Hales Corners, WI 53130; or, by e-mail, to: byleen@execpc.com

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*R. A. Barnett
M. R. Ziegler
K. E. Byleen*

■ Ordering Information

When requesting examination copies or placing orders for this text or any of the related supplementary material listed below, please refer to the corresponding ISBN numbers.

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Contents

Preface xiii

PART ONE

A Library of Elementary Functions 1

CHAPTER 1 A Beginning Library of Elementary Functions 3

- 1-1 Functions 3
- 1-2 Elementary Functions: Graphs and Transformations 23
- 1-3 Linear Functions and Straight Lines 36
- 1-4 Quadratic Functions 53
- Important Terms and Symbols 68
- Review Exercise 69
- Group Activity 1: Introduction to Regression Analysis 74
- Group Activity 2: Mathematical Modeling in Business 75

CHAPTER 2 Additional Elementary Functions 79

- 2-1 Polynomial and Rational Functions 79
- 2-2 Exponential Functions 96
- 2-3 Logarithmic Functions 110
- Important Terms and Symbols 122
- Review Exercise 122
- Group Activity 1: Comparing the Growth of Exponential and Polynomial Functions, and Logarithmic and Root Functions 125
- Group Activity 2: Comparing Regression Models 125

PART TWO Calculus 129

CHAPTER 3 The Derivative 131

- 3-1 Rate of Change and Slope 132
- 3-2 Limits 144
- 3-3 The Derivative 162
- 3-4 Derivatives of Constants, Power Forms, and Sums 175
- 3-5 Derivatives of Products and Quotients 189

3-6	Chain Rule: Power Form	197
3-7	Marginal Analysis in Business and Economics	204
	Important Terms and Symbols	216
	Summary of Rules of Differentiation	216
	Review Exercise	217
	Group Activity 1: Minimal Average Cost	221
	Group Activity 2: Numerical Differentiation on a Graphing Utility	222

CHAPTER 4 Graphing and Optimization 225

4-1	Continuity and Graphs	226
4-2	First Derivative and Graphs	242
4-3	Second Derivative and Graphs	259
4-4	Curve Sketching Techniques: Unified and Extended	275
4-5	Optimization; Absolute Maxima and Minima	292
	Important Terms and Symbols	308
	Review Exercise	309
	Group Activity 1: Maximizing Profit	313
	Group Activity 2: Minimizing Construction Costs	313

CHAPTER 5 Additional Derivative Topics 315

5-1	The Constant e and Continuous Compound Interest	315
5-2	Derivatives of Logarithmic and Exponential Functions	322
5-3	Chain Rule: General Form	334
5-4	Implicit Differentiation	345
5-5	Related Rates	352
	Important Terms and Symbols	358
	Additional Rules of Differentiation	358
	Review Exercise	358
	Group Activity 1: Elasticity of Demand	360
	Group Activity 2: Point of Diminishing Returns	361

CHAPTER 6 Integration 363

6-1	Antiderivatives and Indefinite Integrals	363
6-2	Integration by Substitution	378
6-3	Differential Equations; Growth and Decay	390
6-4	Geometric-Numeric Introduction to the Definite Integral	401
6-5	Definite Integral as a Limit of a Sum; Fundamental Theorem of Calculus	417
	Important Terms and Symbols	435
	Integration Formulas and Properties	436
	Review Exercise	436
	Group Activity 1: Simpson's Rule	440
	Group Activity 2: Bell-Shaped Curves	443