

时代教育 · 国外高校优秀教材精选

微积分

Calculus

(英文版·原书第8版)



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Prentice
Hall

戴尔·沃伯格(Dale Varberg)
(美) 埃德温·J.珀塞尔(Edwin J.Purcell) 著
史蒂文·E.里格登(Steven E.Rigdon)



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1600

1700

Descartes



Newton



Leibniz



Euler



J. Kepler (1571-1630)

— R. Descartes (1596-1650) —

— B. Pascal (1623-1662) —

— I. Newton (1642-1727) —

— G. Leibniz (1646-1716) —

— L'Hôpital (1661-1704) —

— J. Bernoulli (1667-1748) —

— L. Euler (1707-1783)

— M. Agnesi (1692-1717)



Kepler



Pascal



L'Hôpital



Bernoulli

1609

1637

1665

1696

1728

Kepler's laws
of planetary
motion

Descartes'
analytic geometry

Newton discovers
calculus

First calculus text
(L'Hôpital)

Euler introduces e

1800

1900

Lagrange



Other Contributors

Pierre de Fermat (1601-1665)
 Michel Rolle (1652-1719)
 Brook Taylor (1685-1731)
 Colin Maclaurin (1698-1746)

Thomas Simpson (1710-1761)
 Pierre-Simon de Laplace (1749-1827)
 George Green (1793-1841)
 George Gabriel Stokes (1819-1903)

Gauss



Cauchy



Riemann



Lebesgue



Lagrange (1736-1813)

C. Gauss (1777-1855)

A. Cauchy (1789-1857)

K. Weierstrass (1815-1897)

G. Riemann (1826-1866)

J. Gibbs (1839-1903)

S. Kovalevsky (1850-1891)

H. Lebesgue (1875-1941)



Agnesi



Weierstrass



Kovalevsky



Gibbs

1799

1821

1854

1873

1902

Gauss proves
 Fundamental
 Theorem of
 Algebra

Precise notion of
 limit (Cauchy)

Riemann integral

e is transcendental
 (Hermite)

Lebesgue integral

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序

国内出版的理工类非数学专业的微积分教材很多，其中不少是有一定特色的。特别是近几年来随着大学数学教学改革的不深入，反映在教材建设上，其成果还是比较突出的。但从我在教学和教改研究中所读到的教材看，还存在着一些值得讨论的问题。

第一是教材虽多，但在总的体系结构上大体雷同，受原苏联教材的影响还较重。当然，这并不是说这种体系不好，而是太多差异不大的教材，不利于比较和促进教材的建设工作。

第二是教材文风都比较正统，语言不太生动，有种使读者，特别是数学基础差一点的人望而生畏之感。也就是教材的可读性方面值得改进。

第三是习题不够丰富，题型的变化较少，应用问题，特别是有真实数据的、符合我国实际的应用问题很少。

由机械工业出版社组织影印的 Dale Varberg 等编写的《Calculus》第 8 版是一本在美国大学中使用面比较广泛的微积分教材。该书与在美国采用更广泛的微积分教材《Thomas' Calculus》比较，有不少共同之处，如重视应用，便于自学，习题数量与内容比较丰富等等。而较大的差别是该教材比较强调数学的严谨性，例如在极限处理上，虽然也是主要讲函数极限，但书中不但有严格的 ϵ - δ 定义，而且用较大的篇幅在利用 ϵ - δ 定义证明一些极限；许多定理都有较严谨的证明。这一点与我国许多现行的理工科微积分教材比较类似，在美国也是另一种风格的教材。本书强调应用，如数值方法一章；习题数量多，类型多，每章之后有附加内容，有利用图形计算器或数学软件计算的习题或带研究性的小题目等。

本教材的内容有一元微积分，包括函数、极限，函数连续性，导数及其应用，积分及其应用，不定型的极限及广义积分，级数、数值方法及逼近。第二部分是多元微积分，包括空间解析几何，向量，多元函数的导数与二重三重积分，以及向量场的微积分。最后是微分方程。

总之，这种基础数学教材的影印出版，对于我们借鉴国外好的教学经验，推动我国的数学教育改革，特别是对当前提倡的“双语教学”工作，一定会起到很好的作用，取得良好的效果。

谭泽光

清华大学数学科学系

2002 年 4 月

出版说明

随着我国加入 WTO，国际间的竞争越来越激烈，而国际间的竞争实际上也就是人才的竞争、教育的竞争。为了加快培养具有国际竞争力的高水平技术人才，加快我国教育改革的步伐，国家教育部近来出台了一系列倡导高校开展双语教学、引进原版教材的政策。以此为契机，机械工业出版社拟于近期推出一系列国外影印版教材，其内容涉及高等学校公共基础课，以及机、电、信息领域的专业基础课和专业课。

引进国外优秀原版教材，在有条件的学校推动开展英语授课或双语教学，自然也引进了先进的教学思想和教学方法，这对提高我国自编教材的水平，加强学生的英语实际应用能力，使我国的高等教育尽快与国际接轨，必将起到积极的推动作用。

为了做好教材的引进工作，机械工业出版社特别成立了由著名专家组成的国外高校优秀教材审定委员会。这些专家对实施双语教学做了深入细致的调查研究，对引进原版教材提出许多建设性意见，并慎重地对每一本将要引进的原版教材一审再审，精选再精选，确认教材本身的质量水平，以及权威性和先进性，以期所引进的原版教材能适应我国学生的外语水平和学习特点。在引进工作中，审定委员会还结合我国高校教学课程体系的设置和要求，对原版教材的教学思想和方法的先进性、科学性严格把关。同时尽量考虑原版教材的系统性和经济性。

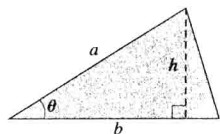
这套教材出版后，我们将根据各高校的双语教学计划，举办原版教材的教师培训，及时地将其推荐给各高校选用。希望高校师生在使用教材后及时反馈意见和建议，使我们更好地为教学改革服务。

机械工业出版社

2002 年 3 月

FORMULAS FROM GEOMETRY

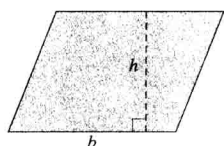
Triangle



$$\text{Area} = \frac{1}{2}bh$$

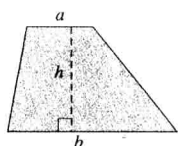
$$\text{Area} = \frac{1}{2}ab \sin \theta$$

Parallelogram



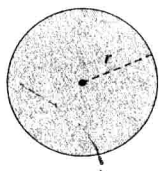
$$\text{Area} = bh$$

Trapezoid



$$\text{Area} = \frac{a+b}{2}h$$

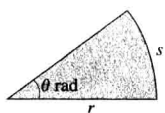
Circle



$$\text{Circumference} = 2\pi r$$

$$\text{Area} = \pi r^2$$

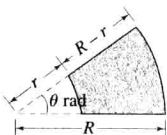
Sector of Circle



$$\text{Arc length } s = r\theta$$

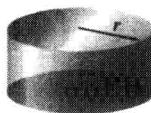
$$\text{Area} = \frac{1}{2}r^2\theta$$

Polar Rectangle



$$\text{Area} = \frac{R+r}{2}(R-r)\theta$$

Right Circular Cylinder



$$\text{Lateral area} = 2\pi rh$$

$$\text{Volume} = \pi r^2 h$$

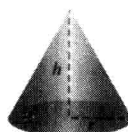
Ball



$$\text{Area} = 4\pi r^2$$

$$\text{Volume} = \frac{4}{3}\pi r^3$$

Right Circular Cone



$$\text{Lateral area} = \pi rs$$

$$\text{Volume} = \frac{1}{3}\pi r^2 h$$

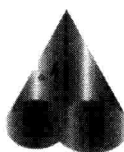
Frustum of Right Circular Cone



$$\text{Lateral area} = \pi s(r+R)$$

$$\text{Volume} = \frac{1}{3}\pi(r^2 + rR + R^2)h$$

General Cone



$$\text{Volume} = \frac{1}{3}(\text{area } B)h$$

Wedge



$$\text{Area } A = (\text{area } B)\sec \theta$$

Preface

The eighth edition of *Calculus* is a modest revision in content, more substantial in the line by line details. Users of previous editions have reported great success and we have no desire to overhaul a workable text.

Classifiers of calculus books would call this a traditional book. Most theorems are proved or left as exercises to prove; when the proof is too deep for a beginning calculus course, we say so, and in many cases we give an argument to at least make the result plausible. Theorems are stated with all conditions clearly spelled out. Through additional problems and projects, we make more use of available technology, such as graphing calculators and computer algebra systems, but the focus is still on understanding the concepts of calculus. While many revisionists see the emphasis on clear, rigorous presentation as being a distraction to the understanding of the concepts of calculus, we see the two as complementary.

A Brief Text The eighth edition continues to be the briefest of all the successful, mainstream calculus texts. We have tried to prevent the text ballooning upward with new topics and alternative approaches. In about 800 pages we cover the major topics in calculus, including a preliminary chapter, material on differential equations, and the appendix.

In the last few decades, students have developed some bad habits. They prefer not to read the textbook. They desire to find the appropriate worked-out example so it can be matched to their homework problem. Our goal with this text continues to keep calculus as a course focused on some few basic ideas centered around words, formulas, and graphs. Solving problem sets, while crucial to developing math skills, should not overshadow the goal of understanding calculus. To encourage students to read the textbook with understanding, we begin every problem set with four fill-in-the-blank items. These test mastery of the basic vocabulary, understanding of the theorems, and ability to apply the concepts in the simplest settings. Students should respond to these items before proceeding to the later problems. We encourage this by giving immediate feedback; the correct answers are given at the end of the problem set. These items also make good quiz questions to see whether students have done the required reading.

Sections are roughly of equal length, allowing an instructor to cover about one section per day. This means that some topics are stretched into two sections. Problem sets gradually lead the student from routine exercises to challenging applied problems.

Number sense distinguishes the mature mathematics student from the neophyte. All calculus students make numerical mistakes in solving problems, but the ones with the number sense recognize an absurd answer and rework the problem. To encourage and develop this important ability, we have emphasized a process we call estimation. We suggest how to make mental estimates, how to arrive at ballpark numerical answers to questions. We do this ourselves in the text in many places, and we propose that students do this, especially in problems marked with the symbol \square .

Use of Technology Many problems in the eighth edition are flagged with one of these symbols:

- \square_C indicates that an ordinary calculator will be helpful in solving the problem.
- \square_{GC} indicates that a graphing calculator is required.
- \square_{CAS} indicates that a computer algebra system is required.

Each chapter now has two Technology Projects (except Chapter 11 which has three). Each project is divided into three parts: Preparation, Using Technology, and Reflection. The Preparation section should be done before attempting to use the technology (a graphing calculator or a CAS). These exercises are important because they force the student to think about the project before diving into the technology. The Reflection section usually asks students questions that are a little deeper; some exercises in the Reflection section require additional use of technology and some don't.

This text now has a website that is free to all students who purchase this text. The address is www.prenhall.com/varberg

Most text examples that contain a geometric picture are to be found animated with "what-if scenarios." Questions accompany each animation. Each section of each chapter contains links to other interesting websites that explicitly cover the topic at hand. Some of these websites contain other faculties' views of how to teach a topic in a clever or insightful way. Each section has True/False quizzes that require students to read. Also, these quizzes can be forwarded directly from students to faculty. Other useful teaching materials will be added over the course of this edition.

There is now available with this text five interchangeable technology manuals: one each for Maple, Mathematica, MATLAB, the Texas Instruments Graphing Calculators, and the Hewlett-Packard Graphing Calculators. The technology projects and problems are identical in each manual. What differs is the specific keystroke or syntax instruction that is given chapter by chapter. Thus, any school could have one instructor teaching calculus with a TI calculator while another instructor uses Maple, while another uses no technology. Each manual can be wrapped with the text for a small additional fee. An added value of using these manuals is that an instructor doesn't have to instruct the student in how to use technology; the manual will do this. The instructor need only teach mathematics. Some Maple and Mathematica code for the Technology Projects is given in the *Student Solutions Manual* and at the website www.prenhall.com/varberg.

Changes in New Edition The basic structure of the book remains unchanged. Here are the most significant changes in the eighth edition.

- The First Fundamental Theorem of Calculus is now stated as $\frac{d}{dx} \int_a^x f(t) dt = f(x)$, and the Second Fundamental Theorem of Calculus states that $\int_a^b f(x) dx = F(b) - F(a)$ if F is an antiderivative of f .
- The order of Chapters 10 and 11 has been reversed. Now the chapter on infinite series comes before the chapter on numerical methods and approximations. With the new ordering, Taylor and Maclaurin polynomials, the first section of Chapter 11, come immediately after Taylor and Maclaurin series, the last section in Chapter 10. Also, Newton's method is now seen as generating a *sequence* that we hope converges to a solution of the equation $f(x) = 0$.
- Linear first-order differential equations are covered in Chapter 7. We use the integrating factor to find solutions.
- Section 11.5, Approximations for Differential Equations, is new. It includes slope fields, Euler's method, and the improved Euler method.
- One additional Technology Project has been added to each chapter, giving two per chapter, except for Chapter 11 where we added two projects, bringing the total to three.

- There are now over 6500 problems, many of which ask students conceptual questions to test their understanding of the concepts of calculus.

Supplements for the Instructor

- *Instructor's Resource Manual*. Contains worked out solutions to all exercises in the text, as well as a printed test bank. (ISBN 0-13-085140-X)
- *PH Custom Test for Windows*. Fully editable test generator with algorithmic capabilities, which provides an instructor's grade book and allows on-line testing. (ISBN 0-13-085090-X)

Supplements for the Student

- *Student Solutions Manual*. Contains worked out solutions for all odd-numbered exercises in the text. (ISBN 0-13-085151-5)
- *How to Study Calculus Booklet*. Contains strategies, suggestions, and hints for learning and achieving success in calculus. (ISBN 0-13-435116-9)

The following platform-specific manuals offer additional technology problem sets and projects, as well as keystroke instructions.

- *A Maple Approach to Calculus* (ISBN 0-13-010583-X)
- *A Mathematica Approach to Calculus* (ISBN 0-13-010586-4)
- *Calculus with MATLAB* (ISBN 0-13-520354-6)
- *A TI Graphing Calculator Approach to Calculus* (ISBN 0-13-020020-4)
- *Calculus with the Hewlett Packard Calculator* (ISBN 0-13-520339-2)

Acknowledgments I would like to thank the staff at Prentice Hall, including George Lobell, Barbara Mack, Gale Epps, and Richard DeLorenzo for their encouragement and their careful attention to the many details associated with preparing a calculus book. Nancy Toscano, of M. and N. Toscano, and Joe Will also deserve special thanks for their careful reading of the manuscript and its problem sets. I wish to thank Kevin Bodden for his tireless work in preparing the solutions for the *Instructor's Resource Manual* and the *Student Solutions Manual*, and to Chris Rigdon for inputting the exam questions for the *Instructor's Resource Manual*. I also wish to thank the faculty at Southern Illinois University Edwardsville, especially Paul Phillips, Chung-wu Ho, Rahim Karimpour, and George Pelekanos for helpful comments.

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S.E.R.
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