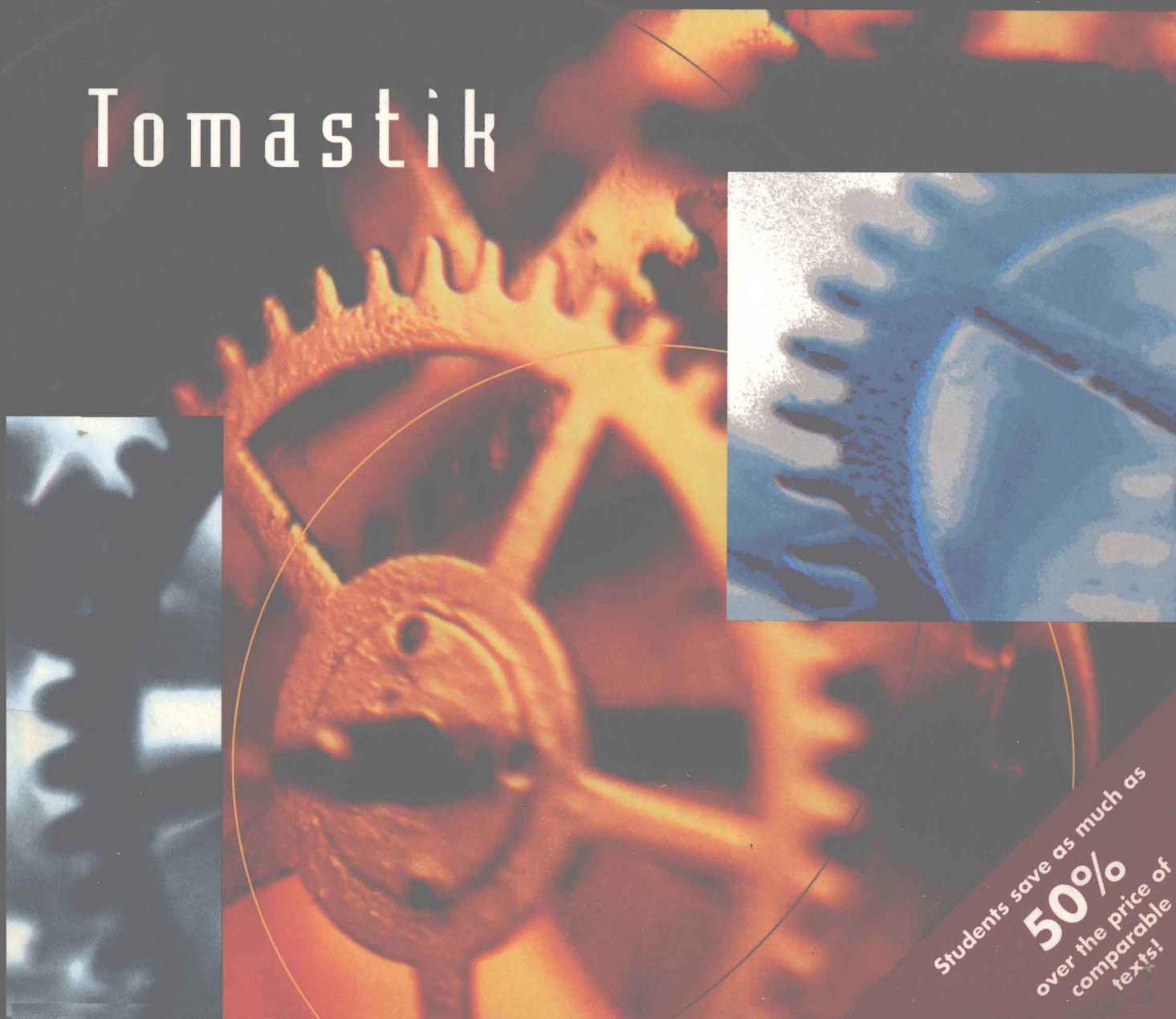
# Applied Calculus

## With Technology

Tomastik



Students save as much as 50% over the price of comparable texts!

# Applied Calculus
## with Technology

by

**Edmond C. Tomastik**

University of Connecticut

**SAUNDERS COLLEGE PUBLISHING**

*Harcourt Brace College Publishers*

Forth Worth Philadelphia San Diego New York Orlando Austin
San Antonio Toronto Montreal London Sydney Tokyo

Copyright © 1996 by Saunders College Publishing.

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from the publisher.

Requests for permission to make copies of any part of the work should be mailed to Permissions Department, Harcourt Brace & Company, 6277 Sea Harbor Drive, Orlando, Florida 32887-6777.

Text Typeface: Times Roman
Compositor: University Graphics, Inc.
Acquisitions Editor: Jay Ricci
Developmental Editor: Anita M Fallon
Managing Editor: Carol Field
Project Editor: Laura Shur
Copy Editor: Linda Davoli
Manager of Art and Design: Carol Bleistine
Art Director: Joan S. Wendt
Cover Designer: Louis Fuiano
Text Artwork: Techsetters, Inc.
Director of EDP: Tim Frelick
Production Manager: Joanne Cassetti
Marketing Manager: Nick Agnew

Cover Credit: Chris Ferebee/Photonica

Printed in the United States of America

Applied Calculus with Technology

ISBN: 0-03-006863-0

Library of Congress Catalog Card Number: 95-071906

5678 053 987654321

This book was printed on acid-free recycled content paper, containing
**MORE THAN**
**10% POSTCONSUMER WASTE**

*To Nancy*

# PREFACE

*Applied Calculus With Technology* is designed to be used in a two semester calculus course aimed at students majoring in business, management, economics, or life/social sciences. The text is written for students with two years of high school algebra. A wide range of topics is included, giving the instructor considerable flexibility in designing a course.

Since the text uses technology as a major tool, the reader is required to use a graphing calculator. The Technology Resource Manual, available with the text, gives all the details in user-friendly terms needed to use a graphing calculator in conjunction with the text. Instructors and students unfamiliar with modern graphing calculators will be surprised at how easy they are to use, and how powerful they have become. This text, together with the accompanying Technology Resource Manual, constitutes a completely organized, self-contained, and easy to use set of material, even for those without any knowledge of graphing calculators.

## PHILOSOPHY

The writing of this text has been guided by four basic principles, all of which are consistent with the movement by national mathematics organizations for reform in calculus teaching and learning.

1. **The Rule of Three:** Every topic should be presented graphically, numerically, and algebraically.
2. **Technology:** Incorporate technology into the calculus instruction.
3. **The Way of Archimedes:** Formal definitions and procedures should evolve from the investigation of practical problems.
4. **Teaching Method:** Teach calculus using the investigative, exploratory approach.

### *The Rule of Three*

By always bringing graphical and numerical, as well as algebraic, viewpoints to bear on each topic, the text presents a conceptual understanding of the calculus that is deep and useful in accommodating diverse applications. Sometimes a problem is done algebraically, then *supported* numerically and/or graphically (with a graphing calculator). Sometimes a problem is done numerically and/or graphically (with a graphing calculator), then *confirmed* algebraically. Other times a problem is done numerically or graphically because the algebra is too time consuming or impossible.



此为试读,需要完整PDF请访问: www.ertongbook.com

### *Technology*

Technology permits more time to be spent on concepts, problem solving, and applications. The technology is used to assist the student to think about the geometric and numerical meaning of the calculus, without undermining the algebraic aspects. In this process, a balanced approach is presented. The text clearly points out that the graphing calculator may not give the whole story, motivating the need to learn the calculus. On the other hand, the text also stresses common situations where exact solutions are impossible, requiring an approximation technique using the graphing calculator. Thus, the graphing calculator is just another tool needed, along with the calculus, if we are to solve a variety of problems in the applications.

### *Applications and the Way of Archimedes*

The text is written for *users* of mathematics. Applications play a central role and are woven into the development of the material. Practical problems are always investigated first, then used to motivate, to maintain interest, and to use as a basis for developing definitions and procedures. Here too, technology plays a natural role, allowing the forbidding and time-consuming difficulties associated with real applications to be overcome.

### *The Investigative, Exploratory Approach*

The text also emphasizes an investigative and exploratory approach to teaching. Whenever practical, the text gives students the opportunity to explore and discover for themselves the basic calculus concepts. Again, technology plays an important role. For example, using their graphing calculators, students discover for themselves the derivatives of $x^2$, $x^3$, and $x^4$, and then generalize to $x^n$. They also discover the derivatives of $\ln x$ and $e^x$. None of this is realistically possible without technology.

Student response in the classroom has been exciting. My students enjoy using their graphing calculators in class and feel engaged and part of the learning process. I find students much more receptive to answering questions concerning their observations and more ready to ask questions.

A particularly effective technique is to take 15 or 20 minutes of class time and have students work in small groups to do an exploration or make a discovery. By walking around the classroom and talking with each group, lively discussions arise, even from students who do not normally participate. After such a minilab, the whole class is ready to discuss the insights gained.

Fully in sync with current goals in teaching and learning mathematics, every section in the text includes an Enrichment Exercise Set that encourages exploration, investigation, critical thinking, writing, and verbalization.

## Which Graphing Calculator?

Any user of this text faces the immediate problem of what "technology" to use. The TI-82 graphing calculator made by Texas Instruments is highly recommended. The text does not require the additional functions found on the Texas Instruments TI-85, which is, in general, more difficult to use. The student should spend a minimum of time mastering the technology, leaving a maximum of time to learn calculus. In this regard the TI-82 strikes a good balance, powerful while still being user-friendly.

Other graphing calculators can be used. The Technology Resource Manual available with this text covers the TI-81, TI-82, TI-85, the Casio fx-7700G and fx-8700G, and the Sharp EL-9200C and EL-9300C. The TI-82, TI-85, and EL-9300C have a significant advantage in this group. Programs used in the text can be readily transferred electronically from calculator to calculator, eliminating time consuming and error prone programming by hand. About 10 or 15 seconds is required to link two of these calcu-

lators, and another second or two to transfer all the needed programs. The TI-82 and TI-85 can communicate with a personal computer and transfer programs. (A special cable and software are needed.) To make this process easier there are two disks available to adopters of the text, one for IBM compatible computers and one for Macintoshes, that contain the many programs used in this text. For more information see your Saunders' sales representative.

### Why Graphing Calculators?

The modern graphing calculator is a more effective practical tool than computers in one-dimensional calculus. Computers, unfortunately, are stuck in a laboratory, graphing calculators are completely mobile. Every student can have one instantly ready for use at any time in the classroom. The graphing calculator can be used at the precise moment in the course when needed, with minilabs of 10 minutes being very practical.

Computers are expensive to purchase and maintain, and become obsolete all too soon. Computers also require rooms and monitors. On the other hand, the expense of graphing calculators can be shouldered by the student, not the institution.

## IMPORTANT FEATURES

**Cost.** We understand the financial burden of buying a text and a graphing calculator. To help ease the student burden, the price of this text is less than half the usual price. Costs have been cut by printing with one color and using a soft cover. We believe that the creative layout of the text makes it visually appealing and user-friendly.

**Style.** The text is designed to implement the philosophy stated earlier. Every section opens by posing an interesting and relevant applied problem using familiar vocabulary, which is later solved in the section after the appropriate mathematics has been developed. Concepts are always introduced intuitively, evolve gradually from the investigation of practical problems or particular cases, and culminate in a definition or result. Students are given the opportunity to investigate and discover concepts for themselves, by using the graphing calculator to create the screens in the text or by doing the Explorations. Topics are presented graphically, numerically, and algebraically to give the reader a deep and conceptual understanding. Scattered throughout the text are historical and anecdotal comments. The historical comments are not only interesting in themselves, but also indicate that mathematics is a continually developing subject. The anecdotal comments relate the material to contemporary real life situations.

**Applications.** The text includes many meaningful applications drawn from a variety of fields, including numerous referenced examples extracted from current journals. Applications are given for all the mathematics that is presented and are used to motivate the student.

**Worked Examples.** Over 400 worked examples, including self-help examples mentioned below, have been carefully selected to take the reader progressively from the simplest idea to the most complex. All the steps needed for the complete solutions are included.

**Screens.** There are over 100 screens shown in the text. In almost all cases, they represent opportunities for the instructor to have the students reproduce these on their graphing calculators at the point in the lecture when they are needed. This allows the student to be an active partner in the learning process, emphasizes the point being made, and makes the classroom more exciting. A majority of the other graphs can also be done on the graphing calculator.

**Explorations.** These explorations are designed to further make the student an active partner in the learning process. Some of these explorations can be done in class, some

can be done outside class, as group or individual projects. Not all of these explorations use the graphing calculator, some ask to solve a problem or make a discovery using pencil and paper.

**Self-Help Exercises.** Immediately preceding each exercise set is a set of Self-Help Exercises. These exercises have been very carefully selected to bridge the gap between the exposition in the chapter and the regular exercise set. By doing these exercises and checking the complete solutions provided, students will be able to test or check their comprehension of the material. This, in turn, will better prepare them to do the exercises in the regular exercise set.

**Exercises.** The book contains over 3300 exercises. The exercises in each set gradually increase in difficulty, concluding with the Enrichment Exercises mentioned below. The exercise sets also include an extensive array of realistic applications from diverse disciplines, including numerous referenced examples extracted from current journals.

**Enrichment Exercises.** Fully in line with current goals in teaching and learning mathematics, every section in the text includes an Enrichment Exercise Set that encourages exploration, investigation, critical thinking, writing, and verbalization.

**End-of-Chapter Projects.** These projects, found at the end of each chapter, are especially good for group assignments. These projects are interesting and will serve to motivate the mathematics student.

**Comment on the Trigonometric Functions.** Before going through a chapter by chapter content overview some comments are needed concerning the trigonometric functions. Many instructors will simply omit the trigonometric functions. For those who include the trigonometric functions, some will wait until the second semester to cover these functions as presented in Chapter 9. Others, however, will want to include the trigonometric functions beginning in Chapter 1, and use them throughout the first semester. The text is written with enough flexibility to accommodate these later instructors.

For example, Sections 9.1 and 9.2 can be presented after Section 1.6 or after Section 1.8. Exercises on derivatives and integrals of the trigonometric functions have been included in many of the Enrichment Exercise sets. The derivatives of $\sin x$ and $\cos x$ are considered in Exercises 55 through 60 in Section 2.4. Notice that the derivatives of these two functions are found graphically in Exercise 59 and 60. Exercise 33 and 34 in Section 2.5 involve the tangent line approximation of these two functions. In Section 3.2, Exercises 49 through 54 involve $\sin x$ and $\cos x$ with the product and quotient rule, while Exercises 55 and 56 ask for the derivation of the derivatives of $\tan x$ and $\cot x$. Further exercise on the derivatives of powers of $\sin x$ and $\cos x$ are given at the end of Section 3.3. Exercises using the chain rule are given at the end of Section 3.4. Exercises in Chapter 5 derive and use the integrals of $\sin \mu$ and $\cos \mu$. Naturally, where appropriate, exercises from Section 9.3, 9.4, and 9.5 can be added to the above list. Thus, the material in Chapter 9 can be easily be integrated into the first five chapters.

## STUDENT AIDS

- **Boldface** is used when defining new terms.
- **Boxes** are used to highlight definitions, theorems, results, and procedures.
- **Remarks** are used to draw attention to important points that might otherwise be overlooked.
- **Warnings** alert students against making common mistakes.
- **Titles** for worked examples help to identify the subject.
- **Chapter summary outlines**, at the end of each chapter, conveniently summarize all the definitions, theorems, and procedures in one place.

- **Review exercises** are found at the end of each chapter.
- **Chapter projects** are found at the end of each chapter.
- **Answers** to odd-numbered exercises and to all the review exercises are provided in an appendix.
- The **Technology Resource Manual** available with this text has all the details, in user-friendly terms, on how to carry out any of the graphing calculator operations used in the text.
- A **Student's Solution Manual** that contains completely worked solutions to all odd-numbered exercises and to all chapter review exercises is available.

## INSTRUCTOR AIDS

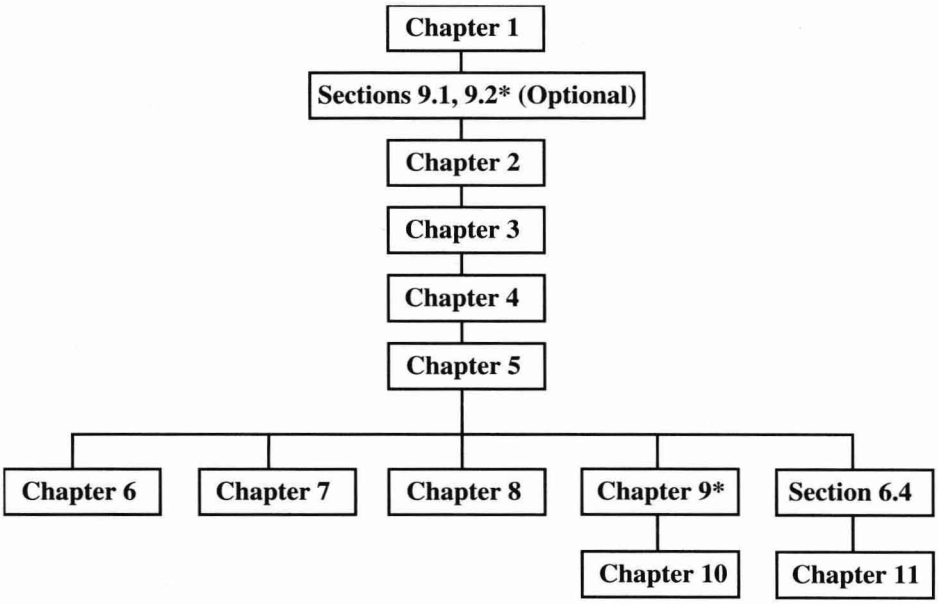
- An **Instructor's Solution Manual** with completely worked solutions to the even-numbered exercises and to all the Explorations is available free to adopters. The **Student's Solution Manual** is free to adopters and contains the completely worked solutions to all odd-numbered and to all chapter review exercises. Between the two manuals all exercises are covered.
- The **Technology Resource Manual**, available with this text has all the details, in user-friendly terms, on how to carry out any of the graphing calculator operations used in the text. The manual includes the Texas Instrument TI-81, TI-82, and TI-85, the Casio fx-7700G and fx-8700G, and the Sharp EL-9200C and EL-9300C.
- **A TI Graphing Calculator Program Disk** is available free to all adopters and contains all the programs found in the text. This disk allows you to download the programs from your PC or Macintosh to a Texas Instrument TI-82 or TI-85, with the proper hardware.
- A **Test Bank** written by Joan Van Glabek (Collier County College) contains 100 questions per chapter and is set up like the exercise sets.
- A **Computerized Test Bank** allows instructors to quickly create, edit and print tests or different versions of tests from the set of test questions accompanying the text. It is available free to adopters and is available in IBM or Mac versions.
- **Graph 2D/3D**, a software package by George Bergeman, Northern Virginia Community College, is available free to users. This software graphs functions in one variable and graphs surfaces of functions in two variables. It also provides computational support for solving calculus problems and investigating concepts. It is available for IBM (or IBM-compatible) computers.

### Custom Publishing

Courses in business calculus are structured in various ways, differing in length, content, and organization. To cater to these differences, Saunders College Publishing is offering **Applied Calculus with Technology** in a custom-publishing format. Instructors can rearrange, add, or cut chapters to produce a text that best meets their needs.

## CHAPTER DEPENDENCIES

The diagram below shows chapter dependencies in Applied Calculus which instructors should consider. Beyond these dependencies, instructors, with custom publishing, are free to choose the topics they want to cover in the order they want to cover them, thereby creating a text that follows their course syllabi.




* See the two paragraphs following "Comments on the Trigonometric Functions" below.

Saunders College Publishing is working hard to provide the highest quality service and product for your courses. If you have any questions about custom publishing, please contact your local Saunders sales representative.

## CONTENT OVERVIEW

**Chapter 1.** Section 1.0 contains some examples that clearly indicate instances when the graphing calculator fails to tell the whole story, and therefore motivates the need to learn the calculus. Chapter 4 features examples for which our current mathematical knowledge is inadequate to find the exact values of critical points, requiring us to use some approximation technique on our graphing calculators. This theme of needing both mathematical analysis and technology to solve important problems continues throughout the text. The rest of Chapter 1 presents a review of algebra topics. Depending on the preparation of the students, some of the material can be omitted. The first section presents standard coverage (with technology) of lines, the second presents linear models, including an introduction to the theory of the firm with some necessary economics background. The third section introduces functions, and the remainder of the chapter considers a variety of functions, together with graphing techniques and combinations of functions.

**Chapter 2.** Chapter 2 begins the study of calculus. The first section introduces limits intuitively, lending support with many geometric and numerical examples. The second section continues with continuity, limits at infinity, and a derivation of the natural exponential function from the idea of continuous compounding. The next two sections cover rates of change, slope of the tangent line to a curve, and the derivative. Using a program provided, students can use their graphing calculators to see secant lines con-

verging to a tangent line to a curve. In the section on derivatives, graphing calculators are used to find the derivative of $f(x) = \ln x$. From the limit definition of derivative we know that for $h$ small, $f'(x) \approx \dfrac{f(x + h) - f(x)}{h}$. We then take $h = 0.001$ and graph the function $g(x) = \dfrac{\ln(x + 0.001) - \ln x}{0.001}$. We see on our graphing calculator screens that $g(x) \approx 1/x$. Since $f'(x) \approx g(x)$, we then have strong evidence that $f'(x) = 1/x$. This is confirmed algebraically later in Chapter 3. The chapter ends with the tangent line approximation and local linearity near a point where the derivative exists.

**Chapter 3.** The first section of the chapter begins with some rules for derivatives. In this section we also discover the derivatives of a number of functions using graphing calculators. Just as we found the derivative of $\ln x$ in the preceding chapter, we graph $g(x) = \dfrac{f(x + 0.001) - f(x)}{0.001}$ for the functions $f(x) = x^2$, $x^3$, and $x^4$, and then discover from our graphing calculator screens what particular function $g(x)$ is in each case. Since $f'(x) \approx g(x)$, we then discover $f'(x)$. We then generalize to $x^n$. In the same way we find the derivative of $f(x) = e^x$. This is an exciting and innovative way for students to find these derivatives. Now that the derivatives of $\ln x$ and $e^x$ are known, these functions can be used in conjunction with the product and quotient rules found in the second section, making this material more interesting and compelling. The third section covers the chain rule, and the fourth section derives the derivatives of the exponential and logarithmic functions in the standard fashion. The last section presents applications to business and economics.

**Chapter 4.** Graphing and curve sketching are introduced in this chapter. Section 1 describes the importance of the first derivative in graphing. We show clearly that our graphing calculator can fail to give a complete picture of the graph of a function, demonstrating the need for the calculus. We also consider examples for which the exact values of the critical points cannot be determined, and thus need to resort to using an approximation technique on our graphing calculators. Section 2 considers important and timely applications to Laffer curves in tax policy and to the harvesting of renewable natural resources. Section 3 presents the second derivative and its use in graphing, while Section 4 continues with more curve sketching. Extensive applications are given, including population growth, radioactive decay, and the logistic equation with derived estimates of the limiting human population of the earth. The chapter ends with optimization, implicit differentiation, related rates, and Newton's method.

**Chapter 5.** The first two sections of this chapter present antiderivatives and substitution. Section 3 lays the groundwork for the definite integral by considering left- and right-hand Riemann sums. Here again the graphing calculator plays a vital role. Using programs provided, students can easily graph the rectangles associated with these Riemann sums, and see graphically and numerically what happens as $n \to \infty$. The chapter continues with the definite integral, fundamental theorem of calculus, area between curves, and presents a number of additional applications of the integral, including average value, density, consumer's and producer's surplus, Lorentz's curves, and money flow.

**Chapter 6.** This chapter contains material on integration by parts, integration using tables, numerical integration, and improper integrals.

**Chapter 7.** The first sections presents an introduction to functions of several variables, including cost and revenue curves, Cobb-Douglas production functions, and level curves. The second section then introduces partial derivatives with applications that include competitive and complementary demand relations. The third section gives the second derivative test for functions of several variables and applied application on optimization. The fourth section covers Lagrange multipliers and carefully avoids algebraic complications. The method of least squares and correlation is presented in Section 5 and the tangent plane approximation is presented in the sixth section. The last section on double integrals covers double integrals over general domains, Riemann

此为试读,需要完整PDF请访问: www.ertongbook.com

sums, and applications to average value and density. A program is given for the graphing calculator to compute Riemann sums over rectangular regions.

**Chapter 8.** This chapter is a brief introduction to differential equations and includes the technique of separation of variables, approximate solutions using Euler's method, some qualitative analysis, and mathematical problems involving the harvesting of a renewable natural resource. The graphing calculator is used to graph approximate solutions and to do some experimentation.

**Chapter 9.** This chapter covers an introduction to the trigonometric functions. The first section starts with angles and the next three section covers the sine and cosine functions, including differentiation and integration. The last section then covers the remaining trigonometric functions. Notice that these sections include extensive business applications, including models by Samuelson [137] and Phillips [138]. Notice in Section 9.3 that the derivatives of $\sin x$ and $\cos x$ are found using the graphing calculator and that the graphing calculator is used throughout this chapter.

**Chapter 10.** This chapter covers Taylor polynomials and infinite series. Sections 10.1, 10.2, and 10.7 constitute a subchapter on Taylor polynomials. Section 10.7 is written so that the reader can go from Section 10.2 directly to Section 10.7. The first section introduces Taylor polynomials and the second section considers the errors in Taylor polynomial approximation. The graphing calculator is used extensively to compare the Taylor polynomial with the approximated function. The last section looks at Taylor series, where the interval of convergence is found analytically in the simpler cases, while graphing calculator experiments cover the more difficult cases. Section 10.3 introduces infinite sequences and Sections 10.4 through 10.6 are on infinite series and includes a variety of test for convergence and divergence.

**Chapter 11.** This chapter is on probability. The first section is a brief review of discrete probability. The second section then considers continuous probability density functions and the third section presents the expected value and variance of these functions. The fourth section covers the normal distribution, arguably the most important probability density function. The graphing calculator is used to do many of the arithmetic calculations and to draw histograms.

## ACKNOWLEDGMENTS

I appreciate Elizabeth Widdicombe, Publisher, and Jay Ricci, Executive Editor, for their generous support of this project. I greatly appreciate the very important help provided by my Developmental Editor, Anita Fallon.

My thanks to Laura Shur, Project Editor, Joan Wendt, Senior Art Director, Linda Davoli, Copy Editor, and Joanne Cassetti, Production Manager for a great job.

I wish to thank the Department of Mathematics here at the University of Connecticut for their collective support, and a particular thanks to Jeffrey Tollefson for his encouragement.

I wish to express my sincere appreciation to each of the reviewers for their many helpful suggestions. Rich Cambell, Butte College, Bob Denton, Orange Coast College, Gudryn Doherty, Community College of Denver, Michael Dutko, University of Scranton, Harvey Greenwald, California State Polytechnic University, Robert Goad, Sam Houston State University, Linda Halligan, Mohawk Valley Community College, Yvette Hester, Texas A & M University, Miles Hubbard, St. Cloud State University, John Lawlor, University of Vermont, Jaclyn LeFebvre, Illinois Central College, Joyce Longman, Villanova University, Mark Palko, University of Arkansas, Don Pierce, Western Oregon State College, Georgia Pyrros, University of Delaware, Geetha Ramanchandra, California State University, Sacremento, Deborah Ritchie, Moorpark College, Dale Rohm, University of Wisconsin—Stevens Point, Arlene Sherburn, Montgomery Col-

lege, Steven Terry, Ricks College, Stuart Thomas, University of Oregon, Richard Witt, University of Wisconsin—Eau Claire, Judith Wolbert, Michigan State University, Cathleen Zucco, LeMoyne College.

Thanks also to the people listed below for taking the time to fill out a detailed questionnaire about their business calculus courses. Their responses were invaluable. Tom Adamson, Phoenix College, Keith Alford, Alcorn State University, Dan Anderson, Parkland College, Chris Barker, DeAnza College, Arlene Blasius, SUNY, College at Old Westbury, Bob Branch, Spokane Community College, Frank Caldwell, York Technical College, Connie Campbell, Millsaps College, Rich Campbell, Butte College, Roger Cooke, University of Vermont, Richard A. Didio, LaSalle University, Diane Doyle, Adirondack Community College, Margaret Ehringer, Indiana University, Southeast, Betty Fein, Oregon State University, James O. Friel, California State University, Fullerton, Deborah Garner, Umpqua Community College, Debbie Garrison, Valencia Community College, East, A. Karen Gragg, New Mexico State University, Carlsbad, Thomas Gruszka, Western New Mexico University, R. Guralnick, University of Southern California, Chris Haddock, Bentley College, Daniel L. Hansen, Northeastern Oklahoma State University, Lonnie Hass, North Dakota State University, Barbara A. Honhart, Baker College, Linda Jones, University of California, Davis, Gerald R. Krusinski, College of Du Page, Larry R. Lance, Columbus State Community College, C. Lando, University of Alaska, Fairbanks, Mary Ann Lee, Mankato State University, Jaclyn LeFebvre, Illinois Central College, M. Lehmann, University of San Francisco, Ricardo A. Martinez, Foothill College, Roger Maurer, Linn-Benton Community College, Ruth A. Meyer, Western Michigan University, David Meyers, Bakersfield College, Syed Moiz, Galveston College, Lorraine Edson-Perone, Cerritos College, Dennis Parker, University of the Pacific, Bob Pawlowski, Lansing Community College, William B. Peirce, Cape Cod Community College, Don Philley, Monterey Pennisula College, Wallace Pye, University of Southern Mississippi, Rosalind Reichard, Elon College, Kathy V. Rodgers, University of Southern Indiana, Howard Rolf, Baylor University, P. Rosnick, Greenfield Community College, Edward Rozema, University of Tennessee, Chattanooga, Frederick M. Russell, Charles County Community College, Tami Ryan, Valencia Community College, Helen E. Salzberg, Rhode Island College, Nancy Sattler, Terra Community College, Dan Schapiro, Yakima Valley Community College, M. Scott, Western Illinois University, Arlene Sherburne, Montgomery College, Toby Shook, Asheville-Buncombe Technical Community College, Minnie W. Shuler, Gulf Coast Community College, Brenda M. Shryock, Wake Technical Community College, Marlene Sims, Kennesaw State College, Gerald Skidmore, Alvin Community College, M. Smith, Georgia State University, Carol Soos, Beleville Area College, Richard Tebbs, Southern Utah University, Steven Terry, Ricks College, Gwen Terwilliger, University of Toledo, Anthony D. Thomas, University of Wisconsin, Platteville, Carolyn R. Thomas, San Diego City College, Stuart Thomas, University of Oregon, Joseph A. Tovissi, Cañada College, Paul J. Welsh, Pima Community College East, Randy Westhoff, Bemidji State University, June White, St. Petersburg Junior College, Jim Wooland, Florida State University, Ben F. Zirkle, Virginia Western Community College.

A particular thanks to Jack Porter and Joan Van Glabek (Collier County College) for checking the accuracy of the manuscript.

On a personal level, I am grateful to my wife Nancy for her love, patience and support.

Edmond Tomastik

*October 1995*

# APPLICATIONS INDEX

## Business


Accelerator-multiplier model, 485
Accounting, 207
Adhesive tape manufacturing, 275
Advertising campaign, 328, 403
Advertising concentration ratio, 51
Advertising intensity, 51
Advertising promotion, 591
Advertising, 103, 382
Agriculture, 121, 205, 275, 392
Air pollution, 307, 522, 529
Alfalfa yields, 33
Apple orchard, 51, 246
Appreciation, 78, 275, 534
Asymptotic plateau, 121
Automobile life, 623
Average air pollution, 307
Average amount of money, 307
Average cost of long-distance call, 150
Average cost, 108, 167, 233
Average price, 307
Average profit, 307
Average revenue, 204, 307

Ball bearing quality control, 620
Banking, 226
Bath towel manufacturing, 335
Battery life, 602
Bicycle sales, 306
Bidding on contracts, 592
Brick manufacturing, 339
Budget equation, 5
Bus company revenue, 246

Camera sales, 281
Capital market line, 96
Cardboard box manufacturing, 281
Cargo, 476
Cereal profits, 361
Clock manufacturing, 281
Cobb-Douglas production function, 362, 370, 396, 399, 407, 421, 426
Color television, 207
Comparing investments, 592
Comparing rates at banks, 78
Competitive demand relation, 377
Competitive pricing, 391, 427
Complementary demand relation, 377
Compound interest, 73, 176
Computer disk manufacture, 275
Concentration of pollutants, 418
Concentration ratio, 51
Consumers' surplus, 321, 325, 335, 339
Container construction, 240
Continuous compounding, 114, 381
Continuous money flow, 317
  continuous reinvestment, 320
  on infinite intervals, 353
  present value on infinite intervals, 353
  present value, 318
  rate, 317
  total income, 317
Copper production, 281, 307, 315, 522, 528
Corn, 205, 234, 392
Cost equation, 61, 132, 141, 147, 163, 169, 183, 184, 185, 189
Cost of fencing, 50
Costs of home contractor, 7, A25
Costs of long-distance call, 119
Cotton, 48, 51 207
Crawfish, 170

Dairy products, 7
Degree of concentration, 51
Delivery fees, 41

Demand equation, 23, 27, 41, 47, 147, 163, 176, 251, 254, 321, 370, 403, 489, 496, 500
Demand for cameras and film, 370
Demand for electricity, 612
Demand for home heating oil, 489, 496, 500
Demand, competitive, 378
Demand, complementary, 378
Density function, 323
Density of pollutants, 324
Depreciation, 119, 281, 307, 328, 533
straight-line, 24, 27
Detergent box weight distribution, 620
Diminishing returns, 224, 233
Discrimination, 7
Disk manufacturing, 275
Disposable diaper market, 169

Economy of scale, 217
Effective annual yield, 76
Elastic demand, 188
Elasticity of demand, 188
Electric can opener manufacturing, 335
Electric utility average cost, 224
Electricity demand, 602, 612
Electricity tax, 41, 119
Employee absences, 593
Employee productivity, 169, 281
Endowment, 543
Engineering production function, 382
Envelope manufacturing, 275
Environmental Protection Agency, 86
Environmental quality, 17
Equilibrium point, 23, 321, 325, 440
Equilibrium price, 23, 321
Equilibrium quantity, 23, 321
Expected return on lottery ticket, 591
Explosive oscillation, 487

Farming, 108, 119
Federal Reserve, 544, 552
Federal Trade Commission, 25
Federal income tax, 37
Federal tax revenue, 208, 213
Fence construction, 208, 213, 230, 238, 246
Fertilizer, 51, 205
Finance, 108, 132, 141
Firm size, 205
Fixed costs, 20
Florida pine plantation, 7

Gas transmission, 382
Growth constant, 70

Hair brush manufacturing, 281
Hand purse manufacturing, 281
Heating oil consumption, 612
Home heating oil demand, 489, 496, 500
Hospitals cost function, 205
Hotel profits, 246
Hotel revenue, 246
Household economics, 16

Industrial plants cost function, 217
Industrial pollutants, 324, 325, 339
Inelastic demand, 188
Inflation, 315
Insurance, 593
Interest per period, 73
Inventory control, 246, 247, 264
Inventory cost model, 242
Inventory, 27
Investment advisor, 592
Investment returns, 592
Investment decision, 324, 355
Investment mix, 17
Irrigation, 48, 51, 92, 119

Kennedy administration tax policy, 210
Knife manufacturing revenue, 275

Labor allocation, 27
Labor market, 207
Laffer curve, 208
Law of supply and demand, 22
Life insurance, 623
Life insurance policy, 593
Life of a part, 1130
Light bulb life span, 600
Linear cost model, 20
Linear revenue model, 20
Lipstick manufacturing, 281
Lottery, 592, 623

Machine allocation, 27
Machine shop operation, 28
Make or buy decision, 27
Manufacturing cost, 21
Manufacturing of boats, 161
Manufacturing profit, 21
Manufacturing revenue, 21

Manufacturing, 623
Marginal average cost, 167
Marginal cost, 161, 185, 189, 190, 328
Marginal productivity of capital, 376
Marginal productivity of labor, 376
Marginal profit, 161
Marginal propensity to consume, 275
Marginal propensity to save, 170, 275
Marginal revenue, 161, 328
Market share, 103, 233
Milk production, 17
Mill price, 25, 205, 308
Mining platinum, 354
Mining, 307, 329, 357
Multiplier effect, 544, 546, 552, 554, 573

Natural gas extraction, 303
Natural resource depletion, 307
Newsletter copies, 620
Nitrogen fertilizer, 92, 205, 392
Nominal rate, 76
Nuclear reactors, 79

Office scheduling, 17
Oil price, 5
Oil production, 280, 307, 522, 528
Oil slick, 253, A24
Oil well income, 318, 324, 325
Oil well price, 319, 353
Optimal mill price, 205, 308

Package construction, 246, 264
Packaging, 40, 427
Paper plate manufacturing revenue, 275
Petroleum consumption, 132
Philadelphia tax structure, 209
Phosphorus fertilizer, 51, 205, 392
Pipe construction, 247
Plant productivity, 233
Plywood, 25
Point of diminishing returns, 233
Pollutants, 147, 307, 339, 354, 465
Portfolio management, 93, 225
Postal rates, 108
Power Rangers, 338
Present value, 77, 119, 353
Price discrimination, 92, 206, 265
Price function, 141
Price of Oil, 5
Prime rate, 41
Process selection and capacity, 28
Producers' surplus, 321, 339
Product liability, 382
Product life, 612
Production function, 51, 362
Production of vacuum cleaners, 15
Productivity, 169, 182, 191, 233, 281
Profit function, 21, 141, 163, 204, 233, 354, 361, 370, 391, 612
Profit, orchard, 51
Profits, furniture store, 7, A24

Quality control, 592

Rail freight, 25, 27
Rate of sales, 335
Reagan administration tax policy, 208
Real estate appreciation, 78
Refrigerator sales, 339
Renewable natural resources, 210
Research personnel, 205
Revenue equation, 55, 132, 141, 163, 169, 176, 182, 189, 204, 224, 308, 315, 348, 409, 612
Revenue, orchard, 50
Revenue, restaurant, 7, A24
Revenue, shoes, 40
Risk in a portfolio, 94
Roulette, 591, 602

Salary equation, 119
Sales commission, 27, 41
Sales equation, 132, 141, 281, 307, 315, 328, 334, 335, 338, 348, 354, 403
Sales of color television, 207
Sales of new product, 315
Sales, 592, 593
Salt shaker manufacturing, 275
Saving for machinery, 78
Scheduling, 17
Scrap value, 24
Shelf-life, 612, 623
Shoulder bag manufacturing, 281
Soda production, 620
Sorghum, 92
Soybeans, 17, 61
Spare parts production, 352
Spark plug manufacturing, 275
Spread of technology, 169, 220, 224
Steal beam quality control, 620
Steel production, 348
Straight-line depreciation, 24, 27
Stumpage value, 220

Sum-of-years-digit depreciation, 275, 307
Supply and demand, 321
  equilibrium point, 321
  equilibrium price, 321
  equilibrium quantity, 321
Supply curve, 23
Supply equation, 521, 528

Table cloth manufacturing, 275
Tape manufacturing, 620
Tax revenue, 208
Taxes, 41
Technological innovation, 119, 169, 234, 434, 535
Telephone company charges, 38
Television, 207
Textile machine, 54
Theater revenue, 240
Threshold strength, 118, 150
Toaster manufacturing, 339
Toothpaste market, 223
Toothpaste, 103, 233
Toxic emissions costs, 169
Toy sales, 339
Transportation charges, A24
Transportation costs, 17, 308
Transportation, trucks, A24

Unit elasticity, 188
United Technologies, 353

VCR life, 603
VCR profits, 203

Wage distribution, 315
Water consumption, 602, 612
Water pollution, 465
Wire manufacturing, 623
Work stoppages, 132

## Life Sciences

AIDS, 295
Alcohol, 593
Allometry, 445
Antarctic blue whale, 212
  carrying capacity, 212
  minimum viable population level, 212
Apple leaves, 51
Apple trees, 112, 163
Average amount of a drug, 308
Average blood pressure, 308
Average concentration of pollutants, 418
Average number of predators, 468
Average number of prey, 468

Bacteria, 147, 150, 163, 307, 348, 409
Bactrocera dorsalis, 119
Beer's law, 510
Beet armyworm, 234
Bifurcation, 575
Biogeography, 94
Biology, 118, 150, 162, 163, 169, 170, 183, 205, 225, 234, 339, 354, 370, 371, 381, 435, 445, 489, A38
Biomass, 210
Bitter bush, 6
Black Death, 173
Blatta germanica, 163
Blood flow, 254, 370
Blood pressure, 308
Blood stream, 265
Blood vessel, 512
Blood, 512
Blue whale fishery, 213
Blue whales, 27, 213
Bollworm, 207
Bombay plague, 295
Bone measurement, 147
Broccoli, 7
Bronchi, 205, 254
Bubonic plague, 203
Bull, 17

Calcium, 7
Cancer, 144
  tumor, 67
Carbon dioxide, 207, 264, 370
Cardiac output, 357, 370
Carrying capacity, 211
Central blood volume, 358
Chaos, 574
Cholesterol, 7
Cigarettes, 593
Cockroach, 163
Colorado potato beetle, 205

此为试读,需要完整PDF请访问: www.ertongbook.com