PREFACE

Calculus instruction continues to evolve. When we look back at the textbooks from which we learned calculus, and even at some more recent textbooks, we often find terse presentations that emphasize formulas and formal proofs and provide limited assistance with developing a real *understanding* of the subject. Now that we have been teachers ourselves for many years, we firmly believe that success in calculus requires one to learn how to think, not just to do. In *Calculus: Concepts and Connections,* we have worked hard to produce a contemporary textbook that is inspired throughout by that belief.

We strongly encourage students to engage with the subject and to think along with the text, gaining a solid understanding of the underlying *concepts*. We take care to fully explain the topics in a clear and highly accessible style. Without sacrificing mathematical accuracy, we consistently opt to use intuitive arguments in place of rigorous proofs, reserving a selection of challenging proofs for an appendix. We strive to offer the most effective presentation possible by employing all of the perspectives in the mathematician's toolbox—algebraic, graphical and numerical. We also offer writing exercises in every section exercise set and "Concepts" exercises in every chapter review to help strengthen students' abilities to verbalize their understanding of the mathematics.

Another way we seek to foster students' conceptual understanding is by highlighting *connections* to previous and subsequent material in both the exposition and the exercises. We employ a wealth of interesting applications and applied examples, many of which are unique to the Smith/Minton series, to illustrate how calculus topics are connected to each other and to the real world. Throughout the text, we encourage students to actively search for patterns among our worked examples.

From our combined 50-plus years of experience teaching calculus, we have a clear sense of the most likely stumbling blocks students will encounter in learning concepts and techniques. Where appropriate, we offer expanded explanations, additional examples and occasionally clues to help students conceptualize the material in their own terms. Many of these extra-help areas are identified with boxes or special icons. For example, a  highlights tips on some of the potential pitfalls students may encounter in problem solving and some of the most useful shortcuts they should know.

TECHNOLOGY USAGE

It is our conviction that graphing calculators and computer algebra systems must not be used indiscriminately. The focus must always remain on the calculus. We have ensured that each of our exercise sets offers an extensive array of problems that should be worked by hand. We also feel, however, that calculus study supplemented with an intelligent use of technology gives students an extremely powerful arsenal of problem-solving skills. A  icon identifies passages in the text in which we provide guidance on how to judiciously use—and not abuse—graphing calculators and computers. We also provide ample opportunity for students to practice using these tools. Exercises that are most easily solved with the aid of a graphing calculator or a computer algebra system are easily identified with a  icon.

CHAPTER CONTENTS

Chapter 0, Preliminaries, consists of a review of background material. Instructors can easily customize their coverage of this chapter for their course needs. Students can also refer to this chapter to refresh their understanding of basic concepts at any point in their study of calculus. We review all elementary functions, including exponential and logarithmic functions, trigonometric and inverse trigonometric functions and hyperbolic functions. We also discuss representations of curves in parametric equations and polar coordinates.

Chapter 1, Limits and Continuity, introduces the central concepts of limit and continuity. Section 1.1 introduces the concept of the limit in terms of two calculations that foreshadow differentiation and integration, respectively. We develop the concept of limit graphically and numerically, with separate sections for basic computational rules and limits involving infinity. In Section 1.6, we provide important insights into the computational and graphical accuracy of computers.

Chapter 2, Differentiation, introduces the derivative, presents the basic rules of differentiation and develops the derivatives of all elementary functions. We then capitalize on the opportunities for further exploration by offering a rich set of examples of chain rules, product rules, quotient rules and applications.

Chapter 3, Applications of Differentiation, explores applications of the derivative. Our discussion of linear approximations leads to an introduction of Newton's method and L'Hôpital's Rule. We follow this with a thorough development of the graphical interpretations of the derivative. Sections on optimization, related rates and general rates of change in economics and the natural sciences complete the chapter.

Chapter 4, Integration, provides an introduction to integration. Starting with the basic problem of how to find the area under a curve, we proceed to the development of summation formulas and antidifferentiation rules and ultimately to the Fundamental Theorem of Calculus. Techniques of integration, including numerical approximations and various symbolic techniques, complete the package.

Chapter 5, Applications of the Definite Integral, presents applications of integration, focusing on the development of the integral formulas. We supplement traditional physics and engineering applications with novel applications from economics and biology. We also offer sections on projectile motion and probability. Throughout, the relationship of the Riemann sum approximation or antiderivative to the physical problem is central to our discussion.

Chapter 6, Differential Equations, consists of an introduction to differential equations. Starting with highly accessible growth and decay problems, we analyze first-order equations using direction fields and solve separable equations. We introduce second-order equations with an emphasis on techniques and applications for linear equations with constant coefficients.

Chapter 7, Infinite Series, presents a thorough coverage of infinite series. We supplement the standard tests for convergence with numerous graphs and tables of calculations to keep the focus on the sums being approximated. Section 7.8 introduces numerous interesting applications of Taylor series, followed by sections on Fourier series and power series solutions of differential equations.

Chapter 8, Vectors and the Geometry of Space, introduces vectors in two and three dimensions and the geometry of three-dimensional space. We use computer graphics extensively in this chapter as a valuable aid to learning. Various applications of the dot product and cross product to physical situations give the students a dynamic visualization of the calculus concepts being covered.

Chapter 9, Vector-Valued Functions, develops the calculus of vector-valued functions and of parametric equations. We use a mixture of hand-drawn graphs and computer graphics to give students an understanding of three-dimensional curves. Our thorough coverage of the motion of objects in three dimensions also promotes the development of visualization skills.

Chapter 10, Functions of Several Variables and Differentiation, presents the calculus of functions of two or more variables. Given the increasing difficulty of visualizing the mathematics in this chapter, our use of graphical, symbolic, numerical and applied approaches is particularly important. We employ a variety of graphics options, including wireframe and parametric plots, to help students focus on the traces and important properties of the functions. A steepest-descent algorithm is introduced to help students visualize the numerical approximations used to maximize a function.

Chapter 11, Multiple Integrals, introduces double and triple integrals. Our emphasis is on helping students to develop insight into using the proper coordinate system and order of integration to simplify a given multiple integral. Applications involving the design of rockets and tennis rackets enliven the discussion.

Chapter 12, Vector Calculus, examines the vector calculus that is essential to an understanding of fluid mechanics and applications in electricity and magnetism. We present and thoroughly interpret numerous graphs. We conclude the chapter with a section of applications, including the derivations of the heat equation, the continuity equation and various versions of Maxwell's equations.

SUPPLEMENTS

Instructor's Solutions Manual (ISBN 0-07-303042-2), An invaluable, timesaving resource, the Instructor's Solutions Manual contains comprehensive, worked-out solutions to the odd- and even-numbered exercises in the text.

Student Solutions Manual (ISBN 0-07-283094-8), The Student Solutions Manual is a helpful reference that contains comprehensive, worked-out solutions to the odd-numbered exercises in the text.

Student Study Guide (ISBN 0-07-303041-4), The Student Study Guide is a practical study aid that reviews key topics and worked examples in each section of the text and summarizes important techniques and problem-solving strategies.

Instructor's Testing and Resource CD-ROM (ISBN 0-07-283097-2), Brownstone Diploma® testing software, available on CD-ROM, offers instructors a quick and easy way to create customized exams and view student results. Instructors may use the software to sort questions by section, difficulty level, and type; add questions and edit existing questions; create multiple versions of questions using algorithmically-randomized variables; prepare multiple-choice quizzes; and construct a grade book.

MathZone www.mathzone.com, McGraw-Hill's MathZone is a cutting-edge, customizable web-based system that offers a complete solution to instructors' online homework, quizzing and testing needs. MathZone guides students through step-by-step solutions to practice problems and facilitates student assessment through the use of algorithmically-generated test questions. Student activity within the MathZone site is automatically graded and accessible to instructors in an integrated, exportable grade book.

MathZone also provides a wide variety of interactive student tutorials, including practice problems; e-Professor, a collection of step-by-step animated instructions for solving exercises from the text; and NetTutor, a live, personalized tutoring service offered via the Internet.

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