PREFACE

The fourteenth edition of *Calculus for Business, Economics, Life Sciences, and Social Sciences, Brief Version* is designed for a one-term course in Calculus for students who have had one to two years of high school algebra or the equivalent. Note that there are now three different versions of applied calculus texts by the same authors:

- **Brief Version**—Entitled *Calculus for Business, Economics, Life Sciences, and Social Sciences, Brief Version.* Contains Chapters 1–7; generally used for a 1-semester course.
- **Full Version**—Entitled *Calculus for Business, Economics, Life Sciences, and Social Sciences.* Contains Chapters 1–11; generally used for a 2-semester course.
- **Version with Finite Math**—Entitled *College Mathematics for Business, Economics, Life Sciences, and Social Sciences.* Contains Finite Math topics and Chapters 1–7 of the calculus text; generally used for a 2-semester course.

The book's overall approach, refined by the authors' experience with large sections of undergraduates, addresses the challenges of teaching and learning when prerequisite knowledge varies greatly from student to student. The authors had three main goals when writing this text:

- 1. To write a text that students can easily comprehend
- **2.** To make connections between what students are learning and how they may apply that knowledge
- **3.** To give flexibility to instructors to tailor a course to the needs of their students.

Many elements play a role in determining a book's effectiveness for students. Not only is it critical that the text be accurate and readable, but also, in order for a book to be effective, aspects such as the page design, the interactive nature of the presentation, and the ability to support and challenge all students have an incredible impact on how easily students comprehend the material. Here are some of the ways this text addresses the needs of students at all levels:

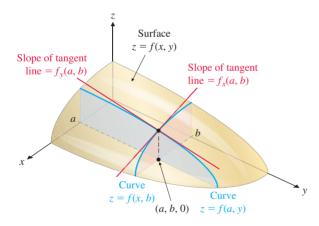
- Page layout is clean and free of potentially distracting elements.
- Matched Problems that accompany each of the completely worked examples help students gain solid knowledge of the basic topics and assess their own level of understanding before moving on.
- Review material (Appendix A and Chapter 1) can be used judiciously to help remedy gaps in prerequisite knowledge.
- A Diagnostic Prerequisite Test prior to Chapter 1 helps students assess their skills, while the Basic Algebra Review in Appendix A provides students with the content they need to remediate those skills.
- Explore and Discuss problems lead the discussion into new concepts or build upon a current topic. They help students of all levels gain better insight into the mathematical concepts through thought-provoking questions that are effective in both small and large classroom settings.
- Instructors are able to easily craft homework assignments that best meet the needs of their students by taking advantage of the variety of types and difficulty levels of the exercises. Exercise sets at the end of each section consist of a Skills Warm-up (four to eight problems that review prerequisite knowledge specific to that section) followed by problems divided into categories A, B, and C by level of difficulty, with level-C exercises being the most challenging.

- The MyLab Math course for this text is designed to help students help themselves and provide instructors with actionable information about their progress. The immediate feedback students receive when doing homework and practice in MyLab Math is invaluable, and the easily accessible eBook enhances student learning in a way that the printed page sometimes cannot.
- Most important, all students get substantial experience in modeling and solving real-world problems through application examples and exercises chosen from business and economics, life sciences, and social sciences. Great care has been taken to write a book that is mathematically correct, with its emphasis on computational skills, ideas, and problem solving rather than mathematical theory.
- Finally, the choice and independence of topics make the text readily adaptable to a variety of courses.

New to This Edition

Fundamental to a book's effectiveness is classroom use and feedback. Now in its fourteenth edition, this text has had the benefit of a substantial amount of both. 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. Additionally, we made the following improvements in this edition:

- Redesigned the text in full color to help students better use it and to help motivate students as they put in the hard work to learn the mathematics (because let's face it—a more modern looking book has more appeal).
- Updated graphing calculator screens to TI-84 Plus CE (color) format.
- Added Reminder features in the side margin to either remind students of a concept that is needed at that point in the book or direct the student back to the section in which it was covered earlier.
 - Revised all 3-dimensional figures in the text using the latest software. The difference in most cases is stunning, as can be seen in the sample figure here. We took full advantage of these updates to make the figures more effective pedagogically.
 - Updated data in examples and exercises. Many modern and student-centered applications have been added to help students see the relevance of the content.
 - In Section 4.5, rewrote Theorem 3 on using the second-derivative test to find absolute extrema, making it applicable to more general invervals.
 - In Section 6.2, rewrote the material on the future value of a continuous income stream to provide a more intuitive and less technical treatment.
- Analyzed aggregated student performance data and assignment frequency data from MyLab Math for the previous edition of this text. The results of this analysis helped improve the quality and quantity of exercises that matter the most to instructors and students.
- Added 625 new exercises throughout the text.
- Moved the final chapter on trigonometry to the longer version of the text (entitled Calculus).



New to MyLab Math

Many improvements have been made to the overall functionality of MyLab Math since the previous edition. However, beyond that, we have also increased and improved the content specific to this text.

- Instructors now have more exercises than ever to choose from in assigning homework. Most new questions are application-oriented. There are approximately 4,210 assignable exercises in MyLab Math for this text. New exercise types include:
 - Additional Conceptual Questions provide support for assessing concepts and vocabulary. Many of these questions are application-oriented.
 - Setup & Solve exercises require students to show how they set up a problem
 as well as the solution, better mirroring what is required of students on tests.
- The Guide to Video-Based Assignments shows which MyLab Math exercises can be assigned for each video. (All videos are also assignable.) This resource is handy for online or flipped classes.
- The Note-Taking Guide provides support for students as they take notes in class. The Guide includes definitions, theorems, and statements of examples but has blank space for students to write solutions to examples and sample problems. The Note-Taking Guide corresponds to the Lecture PowerPoints that accompany the text. The Guide can be downloaded in PDF or Word format from within MyLab Math.
- A full suite of Interactive Figures has been added to support teaching and learning. The figures illustrate key concepts and allow manipulation. They have been designed to be used in lecture as well as by students independently.
- Enhanced Sample Assignments include just-in-time prerequisite review, help keep skills fresh with spaced practice of key concepts, and provide opportunities to work exercises without learning aids so students check their understanding. They are assignable and editable within MyLab Math.
- An Integrated Review version of the MyLab Math course contains premade quizzes to assess the prerequisite skills needed for each chapter, plus personalized remediation for any gaps in skills that are identified.
- **Study Skills Modules** help students with the life skills that can make the difference between passing and failing.
- MathTalk videos highlight applications of the content of the course to business.
 The videos are supported by assignable exercises.
- The *Graphing Calculator Manual* and *Excel Spreadsheet Manual*, both specific to this course, have been updated to support the TI-84 Plus CE (color edition) and Excel 2016, respectively. Both manuals also contain additional topics to support the course. These manuals are within the Tools for Success tab.
- We heard from users that the Annotated Instructor's Edition for the previous edition required too much flipping of pages to find answers, so MyLab Math now contains a downloadable Instructor's Answers document—with all answers in one place. (This augments the downloadable Instructor's Solutions Manual, which contains solutions.)

Trusted Features

Emphasis and Style—As was stated earlier, this text is written for student comprehension. To that end, the focus has been on making the book both mathematically correct and accessible to students. Most derivations and proofs are omitted, except where their inclusion adds significant insight into a particular concept as the emphasis is on computational skills, ideas, and problem solving

- rather than mathematical theory. General concepts and results are typically presented only after particular cases have been discussed.
- Design—One of the hallmark features of this text is the clean, straightforward design of its pages. Navigation is made simple with an obvious hierarchy of key topics and a judicious use of call-outs and pedagogical features. A functional use of color improves the clarity of many illustrations, graphs, and explanations, and guides students through critical steps (see pages 37 and 40).
- Examples—More than 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. The examples are annotated using blue text to the right of each step, and the problem-solving steps are clearly identified. To give students extra help in working through examples, dashed boxes are used to enclose steps that are usually performed mentally and rarely mentioned in other books (see Example 4 on page 9). Though some students may not need these additional steps, many will appreciate the fact that the authors do not assume too much in the way of prior knowledge.
- Matched Problems—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.
- Explore and Discuss—Most every section contains Explore and Discuss problems at appropriate places to encourage students to think about a relationship or process before a result is stated or to investigate additional consequences of a development in the text (see pages 21 and 35). This serves to foster critical thinking and communication skills. The Explore and Discuss material can be used for in-class discussions or out-of-class group activities and is effective in both small and large class settings.
- Exercise Sets—The book contains over 4,200 carefully selected and graded exercises. Many problems have multiple parts, significantly increasing the total number of exercises. Writing exercises, indicated by the icon , provide students with an opportunity to express their understanding of the topic in writing. Answers to all odd-numbered problems are in the back of the book. Exercises are paired so that consecutive odd- and even-numbered exercises are of the same type and difficulty level. Exercise sets are structured to facilitate crafting just the right assignment for students:
 - Skills Warm-up exercises, indicated by W, review key prerequisite knowledge.
 - **Graded exercises**: Levels A (routine, easy mechanics), B (more difficult mechanics), and C (difficult mechanics and some theory) make it easy for instructors to create assignments that are appropriate for their classes.
 - **Applications** conclude almost every exercise set. These exercises are labeled with the type of application to make it easy for instructors to select the right exercises for their audience.
- 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 Index of Applications at the back of the book). Almost every exercise set contains application problems, including applications from business and economics, life sciences, and social sciences. 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

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- emphasis can be placed there. Most of the applications are simplified versions of actual real-world problems inspired by professional journals and books. No specialized experience is required to solve any of the application problems.
- Graphing Calculator and Spreadsheets—Although access to a graphing calculator or spreadsheets is not assumed, it is likely that many students will want to make use of this technology. To assist these students, optional graphing calculator and spreadsheet activities are included in appropriate places. These include brief discussions in the text, examples or portions of examples solved on a graphing calculator or spreadsheet, and exercises for the students to solve. For example, linear regression is introduced in Section 1.3, and regression techniques on a graphing calculator are used at appropriate points to illustrate mathematical modeling with real data. All the optional graphing calculator material is clearly identified with the icon and can be omitted without loss of continuity, if desired. Graphing calculator screens displayed in the text are actual output from the TI-84 Plus CE (color edition) graphing calculator.

Additional Pedagogical Features

The following features, while helpful to any student, are particularly helpful to students enrolled in a large classroom setting where access to the instructor is more challenging or just less frequent. These features provide much-needed guidance for students as they tackle difficult concepts.

- Call-out boxes highlight important definitions, results, and step-by-step processes (see pages 56, 62, and 63).
- Caution statements appear throughout the text where student errors often occur (see pages 11 and 81).
- Conceptual Insights, appearing in nearly every section, often make explicit connections to previous knowledge but sometimes encourage students to think beyond the particular skill they are working on and attain a more enlightened view of the concepts at hand (see pages 19 and 33).
- Diagnostic Prerequisite Test, located on pages xvii and xviii, provides students with a tool to assess their prerequisite skills prior to taking the course. The Basic Algebra Review, in Appendix A, provides students with seven sections of content to help them remediate in specific areas of need. Answers to the Diagnostic Prerequisite Test are at the back of the book and reference specific sections in the Basic Algebra Review or Chapter 1 for students to use for remediation.
- Chapter Reviews—Often it is during the preparation for a chapter exam that concepts gel for students, making the chapter review material particularly important. The chapter review sections in this text include a comprehensive summary of important terms, symbols, and concepts, keyed to completely worked examples, followed by a comprehensive set of Review Exercises. Answers to Review Exercises are included at the back of the book; each answer contains a reference to the section in which that type of problem is discussed so students can remediate any deficiencies in their skills on their own.

Content

The text begins with the development of a library of elementary functions in Chapter 1, including their properties and applications. Many students will be familiar with most, if not all, of the material in this introductory chapter. Depending on students'

preparation and the course syllabus, an instructor has several options for using the first chapter, including the following:

- Skip Chapter 1 and refer to it only as necessary later in the course.
- Cover Section 1.3 quickly in the first week of the course, emphasizing pricedemand equations, price-supply equations, and linear regression, but skip the rest of Chapter 1.
- Cover Chapter 1 systematically before moving on to other chapters.

The calculus material consists of differential calculus (Chapters 2–4), integral calculus (Chapters 5 and 6), and multivariable calculus (Chapter 7). In general, Chapters 2–5 must be covered in sequence; however, certain sections can be omitted or given brief treatments, as pointed out in the discussion that follows.

Chapter 2 introduces the derivative. The first three sections cover limits (including infinite limits and limits at infinity), continuity, and the limit properties that are essential to understanding the definition of the derivative in Section 2.4. The remaining sections cover basic rules of differentiation, differentials, and applications of derivatives in business and economics. The interplay between graphical, numerical, and algebraic concepts is emphasized here and throughout the text.

In **Chapter 3** the derivatives of exponential and logarithmic functions are obtained before the product rule, quotient rule, and chain rule are introduced. Implicit differentiation is introduced in Section 3.5 and applied to related rates problems in Section 3.6. Elasticity of demand is introduced in Section 3.7. The topics in these last three sections of Chapter 3 are not referred to elsewhere in the text and can be omitted.

Chapter 4 focuses on graphing and optimization. The first two sections cover first-derivative and second-derivative graph properties. L'Hôpital's rule is discussed in Section 4.3. A graphing strategy is introduced in Section 4.2 and developed in Section 4.4. Optimization is covered in Sections 4.5 and 4.6, including examples and problems involving endpoint solutions.

Chapter 5 introduces integration. The first two sections cover antidifferentiation techniques essential to the remainder of the text. Section 5.3 discusses some applications involving differential equations that can be omitted. The definite integral is defined in terms of Riemann sums in Section 5.4 and the Fundamental Theorem of Calculus is discussed in Section 5.5. As before, the interplay between graphical, numerical, and algebraic properties is emphasized.

Chapter 6 covers additional integration topics and is organized to provide maximum flexibility for the instructor. The first section extends the area concepts introduced in Chapter 5 to the area between two curves and related applications. Section 6.2 covers three more applications of integration, and Sections 6.3 and 6.4 deal with additional methods of integration, including integration by parts, the trapezoidal rule, and Simpson's rule. Any or all of the topics in Chapter 6 can be omitted.

Chapter 7 deals with multivariable calculus. The first five sections can be covered any time after Section 4.6 has been completed. Sections 7.6 and 7.7 require the integration concepts discussed in Chapter 5.

Appendix A contains a concise review of basic algebra that may be covered as part of the course or referenced as needed. Appendix B (available online at goo.gl/mjbXrG) contains additional topics that can be covered in conjunction with certain sections in the text, if desired.

Accuracy 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. If an error should be found, the authors would be

grateful if notification were sent to Karl E. Byleen, 9322 W. Garden Court, Hales Corners, WI 53130; or by e-mail to kbyleen@wi.rr.com.

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The following faculty members provided direction on the development of the MyLab Math course for this edition:

Emil D. Akli, Harold Washington College

Clark Bennett, University of South Dakota

Latrice N. Bowman, University of Alaska, Fairbanks

Debra Bryant, Tennessee Tech University

Burak Reis Cebecioglu, Grossmont College

Christine Curtis, Hillsborough Community College

Kristel Ehrhardt, Montgomery College, Germantown

Nicole Gesiskie, Luzerne County Community College

Robert G. Hinkle, Germanna Community College

Abushieba Ibrahim, Broward College

Elaine Jadacki, Montgomery College

Kiandra Johnson, Spelman College

Jiarong Li, Harold Washington College

Cristian Sabau, Broward College

Ed W. Stringer, III, Florida State College at Jacksonville

James Tian, Hampton University

Pengfei Yao, Southwest Tennessee Community College

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MyLab Math Online Course for Calculus for Business, Economics, Life Sciences, and Social Sciences, Brief Version, 14e (access code required)

MyLabTM Math is available to accompany Pearson's market-leading text offerings. To give students a consistent tone, voice, and teaching method, each text's flavor and approach are tightly integrated throughout the accompanying MyLab Math course, making learning the material as seamless as possible.

Preparedness

One of the biggest challenges in applied math courses is making sure students are adequately prepared with the prerequisite skills needed to successfully complete their course work. MyLab Math supports students with just-in-time remediation and key-concept review.

NEW! Integrated Review Course

An Integrated Review version of the MyLab Math course contains premade, assignable quizzes to assess the prerequisite skills needed for each chapter, plus personalized remediation for any gaps in skills that are identified. Each student, therefore, receives just the help that he or she needs—no more, no less.

NEW! Study Skills Modules

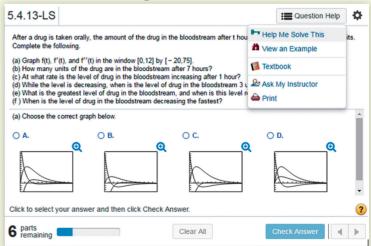
Study skills modules help students with the life skills that can make the difference between passing and failing.

Developing Deeper Understanding

MyLab Math provides content and tools that help students build a deeper understanding of course content than would otherwise be possible.

Exercises with Immediate Feedback

Homework and practice exercises for this text regenerate algorithmically to give students unlimited opportunity for practice and mastery. MyLab Math provides helpful feedback when students enter incorrect answers and includes the optional learning aids Help Me Solve This, View an Example, videos, and/or the eText.

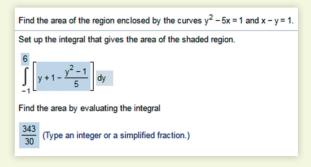


NEW! Additional Conceptual Questions

Additional Conceptual Questions provide support for assessing concepts and vocabulary. Many of these questions are application-oriented. They are clearly labeled "Conceptual" in the Assignment Manager.

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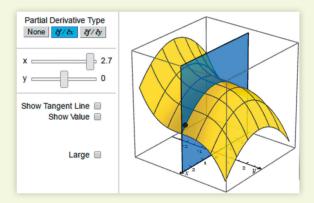


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These assignments include just-in-time prerequisite review, help keep skills fresh with spaced practice of key concepts, and provide opportunities to work exercises without learning aids so students check their understanding. They are assignable and editable within MyLab Math.

NEW! Interactive Figures

A full suite of Interactive Figures has been added to support teaching and learning. The figures illustrate key concepts and allow manipulation. They are designed to be used in lecture as well as by students independently.



Instructional Videos

Every example in the text has an instructional video tied to it that can be used as a learning aid or for self-study. MathTalk videos were added to highlight business applications to the course content, and a Guide to Video-Based Assignments shows which MyLab Math exercises can be assigned for each video.

NEW! Note-Taking Guide (downloadable)

These printable sheets, developed by Ben Rushing (Northwestern State University) provide support for students as they take notes in class. They include preprinted definitions, theorems, and statements of examples but have blank space for students to write solutions to examples and sample problems. The *Note-Taking Guide* corresponds to the Lecture PowerPoints that accompany the text. The *Guide* can be downloaded in PDF or Word format from within MyLab Math from the Tools for Success tab.

Graphing Calculator and Excel Spreadsheet Manuals (downloadable)

Graphing Calculator Manual by Chris True, University of Nebraska
Excel Spreadsheet Manual by Stela Pudar-Hozo, Indiana University–Northwest
These manuals, both specific to this course, have been updated to support the TI-84 Plus CE (color edition) and Excel 2016, respectively. Instructions are ordered by mathematical topic. The files can be downloaded from within MyLab Math from the Tools for Success tab.

Student's Solutions Manual (softcover and downloadable)

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Written by John Samons (Florida State College), the *Student's Solutions Manual* contains worked-out solutions to all the odd-numbered exercises. This manual is available in print and can be downloaded from within MyLab Math within the Chapter Contents tab.

A Complete eText

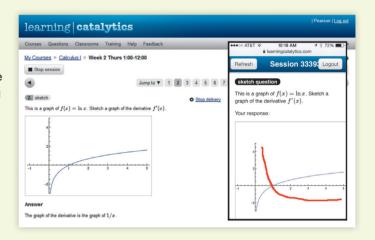
Students get unlimited access to the eText within any MyLab Math course using that edition of the textbook. The Pearson eText app allows existing subscribers to access their titles on an iPad or Android tablet for either online or offline viewing.

Supporting Instruction

MyLab Math comes from an experienced partner with educational expertise and an eye on the future. It provides resources to help you assess and improve students' results at every turn and unparalleled flexibility to create a course tailored to you and your students.

Learning Catalytics™

Now included in all MyLab Math courses, this student response tool uses students' smartphones, tablets, or laptops to engage them in more interactive tasks and thinking during lecture. Learning CatalyticsTM fosters student engagement and peer-to-peer learning with real-time analytics. Access pre-built exercises created specifically for this course.



PowerPoint® Lecture Slides (downloadable)

Classroom presentation slides feature key concepts, examples, and definitions from this text. They are designed to be used in conjunction with the Note-Taking Guide that accompanies the text. They can be downloaded from within MyLab Math or from Pearson's online catalog, **www.pearson.com**.

Learning Worksheets

Written by Salvatore Sciandra (Niagara County Community College), these worksheets include key chapter definitions and formulas, followed by exercises for students to practice in class, for homework, or for independent study. They are downloadable as PDFs or Word documents from within MyLab Math.

Comprehensive Gradebook

The gradebook includes enhanced reporting functionality such as item analysis and a reporting dashboard to allow you to efficiently manage your course. Student performance data is presented at the class, section, and program levels in an accessible, visual manner so you'll have the information you need to keep your students on track.



TestGen[®]

TestGen® (www.pearson.com/testgen) enables instructors to build, edit, print, and administer tests using a computerized bank of questions developed to cover all the objectives of the text. TestGen is algorithmically based, allowing instructors to create multiple but equivalent versions of the same question or test with the click of a button. Instructors can also modify test bank questions or add new questions. The software and test bank are available for download from Pearson's online catalog, www.pearson.com. The questions are also assignable in MyLab Math.

Instructor's Solutions Manual (downloadable)

Written by Garret J. Etgen (University of Houston) and John Samons (Florida State College), the *Instructor's Solutions Manual* contains worked-out solutions to all the even-numbered exercises. It can be downloaded from within MyLab Math or from Pearson's online catalog, **www.pearson.com**.

Accessibility

Pearson works continuously to ensure our products are as accessible as possible to all students. We are working toward achieving WCAG 2.0 Level AA and Section 508 standards, as expressed in the Pearson Guidelines for Accessible Educational Web Media, www.pearson.com/mylab/math/accessibility.

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