Preface

By:

OpenStaxCollege

Welcome to *Precalculus*, an OpenStax College resource. This textbook has been created with several goals in mind: accessibility, customization, and student engagement—all while encouraging students toward high levels of academic scholarship. Instructors and students alike will find that this textbook offers a strong foundation in precalculus in an accessible format.

About OpenStax College

OpenStax College is a non-profit organization committed to improving student access to quality learning materials. Our free textbooks go through a rigorous editorial publishing process. Our texts are developed and peer-reviewed by educators to ensure they are readable, accurate, and meet the scope and sequence requirements of today's college courses. Unlike traditional textbooks, OpenStax College resources live online and are owned by the community of educators using them. Through our partnerships with companies and foundations committed to reducing costs for students, OpenStax College is working to improve access to higher education for all. OpenStax College is an initiative of Rice University and is made possible through the generous support of several philanthropic foundations. OpenStax College textbooks are used at many colleges and universities around the world. Please go to https://openstaxcollege.org/pages/adoptions to see our rapidly expanding number of adoptions.

About OpenStax College's Resources

OpenStax College resources provide quality academic instruction. Three key features set our materials apart from others: they can be customized by instructors for each class, they are a "living" resource that grows online through contributions from educators, and they are available free or for minimal cost.

Customization

OpenStax College learning resources are designed to be customized for each course. Our textbooks provide a solid foundation on which instructors can build, and our resources are conceived and written with flexibility in mind. Instructors can select the

sections most relevant to their curricula and create a textbook that speaks directly to the needs of their classes and student body. Teachers are encouraged to expand on existing examples by adding unique context via geographically localized applications and topical connections.

Precalculus can be easily customized using our online platform (http://cnx.org/content/col11667/latest/). Simply select the content most relevant to your current semester and create a textbook that speaks directly to the needs of your class. Precalculus is organized as a collection of sections that can be rearranged, modified, and enhanced through localized examples or to incorporate a specific theme to your course. This customization feature will ensure that your textbook truly reflects the goals of your course.

Curation

To broaden access and encourage community curation, *Precalculus* is "open source" licensed under a Creative Commons Attribution (CC-BY) license. The mathematics community is invited to submit feedback to enhance and strengthen the material and keep it current and relevant for today's students. Submit your suggestions to info@openstaxcollege.org, and check in on edition status, alternate versions, errata, and news on the StaxDash at http://openstaxcollege.org.

Cost

Our textbooks are available for free online, and in low-cost print and e-book editions.

About *Precalculus*

Precalculus is intended for college-level precalculus students. Since precalculus courses vary from one institution to the next, we have attempted to meet the needs of as broad an audience as possible, including all of the content that might be covered in any particular course. The result is a comprehensive book that covers more ground than an instructor could likely cover in a typical one- or two-semester course; but instructors should find, almost without fail, that the topics they wish to include in their syllabus are covered in the text.

Many chapters of Openstax College *Precalculus* are suitable for other freshman and sophomore math courses such as College Algebra and Trigonometry; however, instructors of those courses might need to supplement or adjust the material. Openstax will also be releasing *College Algebra* and *Algebra and Trigonometry* titles tailored to the particular scope, sequence, and pedagogy of those courses.

Coverage and Scope

Precalculus contains twelve chapters, roughly divided into three groups.

Chapters 1-4 discuss various types of functions, providing a foundation for the remainder of the course.

- Chapter 1: Functions
- Chapter 2: Linear Functions
- Chapter 3: Polynomial and Rational Functions
- Chapter 4: Exponential and Logarithmic Functions

Chapters 5-8 focus on Trigonometry. In Precalculus, we approach trigonometry by first introducing angles and the unit circle, as opposed to the right triangle approach more commonly used in College Algebra and Trigonometry courses.

- Chapter 5: Trigonometric Functions
- Chapter 6: Periodic Functions
- Chapter 7: Trigonometric Identities and Equations
- Chapter 8: Further Applications of Trigonometry

Chapters 9-12 present some advanced Precalculus topics that build on topics introduced in chapters 1-8. Most Precalculus syllabi include some of the topics in these chapters, but few include all. Instructors can select material as needed from this group of chapters, since they are not cumulative.

- Chapter 9: Systems of Equations and Inequalities
- Chapter 10: Analytic Geometry
- Chapter 11: Sequences, Probability and Counting Theory
- Chapter 12: Introduction to Calculus

All chapters are broken down into multiple sections, the titles of which can be viewed in the Table of Contents.

Development Overview

Openstax *Precalculus* is the product of a collaborative effort by a group of dedicated authors, editors, and instructors whose collective passion for this project has resulted in a text that is remarkably unified in purpose and voice. Special thanks is due to our Lead Author, Jay Abramson of Arizona State University, who provided the overall vision for the book and oversaw the development of each and every chapter, drawing up the initial blueprint, reading numerous drafts, and assimilating field reviews into actionable revision plans for our authors and editors.

Preface

The first eight chapters are a derivative work, built on the foundation of *Precalculus: An Investigation of Functions*, by David Lippman and Melonie Rasmussen. Chapters 9-12 were written and developed from by our expert and highly experienced author team. All twelve chapters follow a new and innovative instructional design, and great care has been taken to maintain a consistent voice from cover to cover. New features have been introduced to flesh out the instruction, all of the graphics have been re-done in a more contemporary style, and much of the content has been revised, replaced, or supplemented to bring the text more in line with mainstream approaches to teaching Precalculus.

Accuracy of the Content

We have taken great pains to ensure the validity and accuracy of this text. Each chapter's manuscript underwent at least two rounds of review and revision by a panel of active Precalculus instructors. Then, prior to publication, a separate team of experts checked all text, examples, and graphics for mathematical accuracy; multiple reviewers were assigned to each chapter to minimize the chances of any error escaping notice. A third team of experts was responsible for the accuracy of the Answer Key, dutifully re-working every solution to eradicate any lingering errors. Finally, the editorial team conducted a multi-round post-production review to ensure the integrity of the content in its final form. The Solutions Manual, which was written and developed after the Student Edition, has also been rigorously checked for accuracy following a process similar to that described above. Incidentally, the act of writing out solutions step-by-step served as yet another round of validation for the Answer Key in the back of the Student Edition.

In spite of the efforts described above, we acknowledge the possibility that—as with any textbook—some errata have slipped past the guards. We encourage users to report errors via our Errata page.

Pedagogical Foundations and Features

Learning Objectives

Each chapter is divided into multiple sections (or modules), each of which is organized around a set of learning objectives. The learning objectives are listed explicitly at the beginning of each section, and are the focal point of every instructional element

Narrative text

Narrative text is used to introduce key concepts, terms, and definitions, to provide real-world context, and to provide transitions between topics and examples. Throughout this book, we rely on a few basic conventions to highlight the most important ideas:

- Key terms are boldfaced, typically when first introduced and/or when formally defined
- Key concepts and definitions are called out in a blue box for easy reference.
- Key equations, formulas, theorems, identities, etc. are assigned a number, which appears near the right margin. Occasionally the text may refer back to an equation or formula by its number.
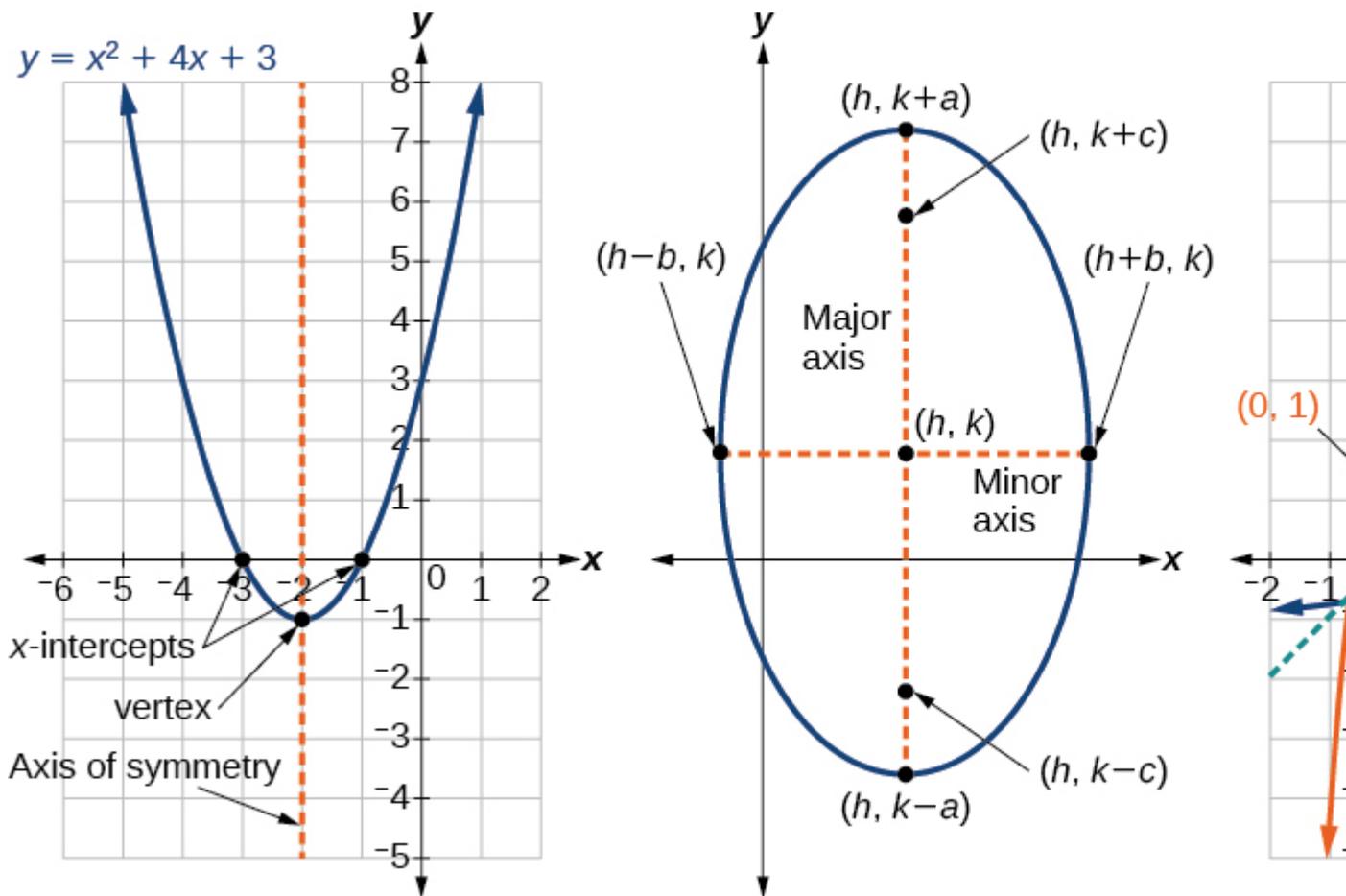
Example

Each learning objective is supported by one or more worked examples, which demonstrate the problem-solving approaches that students must master. Typically, we include multiple Examples for each learning objective in order to model different approaches to the same type of problem, or to introduce similar problems of increasing complexity. All told, there are more than 650 Examples, or an average of about 55 per chapter.

All Examples follow a simple two- or three-part format. First, we pose a problem or question. Next, we demonstrate the Solution, spelling out the steps along the way. Finally (for select Examples), we conclude with an Analysis reflecting on the broader implications of the Solution just shown.

Figures

Openstax *Precalculus* contains more than 2000 figures and illustrations, the vast majority of which are graphs and diagrams. Art throughout the text adheres to a clear, understated style, drawing the eye to the most important information in each figure while minimizing visual distractions. Color contrast is employed with discretion to distinguish between the different functions or features of a graph.

Supporting Features

Four small but important features, each marked by a distinctive icon, serve to support Examples.

How To: A "How To" is a list of steps necessary to solve a certain type of problem. A How To typically precedes an Example that proceeds to demonstrate the steps in action.

Try It: A "Try It" exercise immediately follows an Example or a set of related Examples, providing the student with an immediate opportunity to solve a similar problem. In the Online version of the text, students can click an Answer link directly below the question to check their understanding. In other versions, answers to the Try-It exercises are located in the Answer Key.

 A Q&A may appear at any point in the narrative, but most often follows an Example. This feature pre-empts misconceptions by posing a commonly asked yes/no question, followed by a detailed answer and explanation.

 The "Media" icon appears at the conclusion of each section, just prior to the Section Exercises. This icon marks a list of links to online video tutorials that reinforce the concepts and skills introduced in the section.

Disclaimer: While we have selected tutorials that closely align to our learning objectives, we did not produce these tutorials, nor were they specifically produced or tailored to accompany Openstax *Precalculus*. We are deeply grateful to James Sousa for compiling his incredibly robust and excellent library of video tutorials, which he has made available to the public under a CC-BY-SA license at http://mathispower4u.yolasite.com/. Most or all of the videos to which we link in our "Media" feature (plus many more) are found in the Algebra 2 and Trigonometry video libraries at the above site.

Section Exercises

Each section of every chapter concludes with a well-rounded set of exercises that can be assigned as homework or used selectively for guided practice. With over 5900 exercises across the 12 chapters, instructors should have plenty to choose from

5,924 total exercises. Includes Chapter Reviews and Practice Tests.
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Section Exercises are organized by question type, and generally appear in the following order:

- **Verbal** questions assess conceptual understanding of key terms and concepts.
- **Algebraic** problems require students to apply algebraic manipulations demonstrated in the section.
- **Graphical** problems assess students' ability to interpret or produce a graph.
- **Numeric** problems require the student perform calculations or computations.
- **Technology** problems encourage exploration through use of a graphing utility, either to visualize or verify algebraic results or to solve problems via an alternative to the methods demonstrated in the section.

- **Extensions** pose problems more challenging than the Examples demonstrated in the section. They require students to synthesize multiple learning objectives or apply critical thinking to solve complex problems.
- **Real-World Applications** present realistic problem scenarios from fields such as physics, geology, biology, finance, and the social sciences.

Chapter Review Features

Each chapter concludes with a review of the most important takeaways, as well as additional practice problems that students can use to prepare for exams.

- **Key Terms** provides a formal definition for each bold-faced term in the chapter.
- **Key Equations** presents a compilation of formulas, theorems, and standard-form equations.
- **Key Concepts** summarizes the most important ideas introduced in each section, linking back to the relevant Example(s) in case students need to review.
- **Chapter Review Exercises** include 40-80 practice problems that recall the most important concepts from each section.
- **Practice Test** includes 25-50 problems assessing the most important learning objectives from the chapter. Note that the practice test is not organized by section, and may be more heavily weighted toward cumulative objectives as opposed to the foundational objectives covered in the opening sections.
- **Answer Key** includes the answers to all Try It exercises and every other exercise from the Section Exercises, Chapter Review Exercises, and Practice Test.

Ancillaries

OpenStax projects offer an array of ancillaries for students and instructors. Currently the following resources are available.

- *Instructor's Solutions Manual*
- *Student's Solutions Manual*
- *PowerPoint Slides*

Please visit http://openstaxcollege.org to view an up-to-date list of the Learning Resources for this title and to find information on accessing these resources.

Online Homework

WebAssign is an independent online homework and assessment solution first launched at North Carolina State University in 1997. Today, WebAssign is an employee-owned benefit corporation and participates in the education of over a million students each year. WebAssign empowers faculty to deliver fully customizable assignments and high quality content to their students in an interactive online environment. WebAssign supports Precalculus with hundreds of problems covering every concept in the course, each containing algorithmically-generated values and links directly to the eBook providing a completely integrated online learning experience.

Learningpod is the best place to find high-quality practice and homework questions. Through our partnership with OpenStax College we offer easy-to-use assignment and reporting tools for professors and a beautiful practice experience for students. You can find questions directly from this textbook on Learningpod.com or through the OpenStax mobile app. Look for our links at the end of each chapter!
Practice questions on the Learningpod website: www.learningpod.com
Download the OpenStax Companion Workbooks app (iOS): http://bit.ly/openstaxworkbooks

About Our Team

Lead Author, Senior Content Expert

Jay Abramson has been teaching Precalculus for 33 years, the last 14 at Arizona State University, where he is a principal lecturer in the School of Mathematics and Statistics. His accomplishments at ASU include co-developing the university's first hybrid and online math courses as well as an extensive library of video lectures and tutorials. In addition, he has served as a contributing author for two of Pearson Education's math programs, NovaNet Precalculus and Trigonometry. Prior to coming to ASU, Jay taught at Texas Tech University and Amarillo College. He received Teacher of the Year awards at both institutions.

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