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ANALYTIC TRIGONOMETRY

WITH APPLICATIONS

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ANALYTIC TRIGONOMETRY

WITH APPLICATIONS

Sixth Edition

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Analytic Trigonometry with Applications, Sixth Edition, has benefited from the generous response from users of the earlier editions. Prerequisites for the book are one and a half to two years of high school algebra and one year of high school geometry or their equivalents.

We have taken great care to produce a book that students can actually read, understand, and enjoy. To gain student interest quickly, the text moves directly into trigonometric concepts and applications and reviews essential material from prerequisite courses only as needed. Almost every concept is illustrated by an example followed by a matching problem (with the answers near the end of a section) to encourage an active rather than passive involvement in the learning process. Concept development proceeds from the concrete to the abstract (e.g., right triangle definitions of the trigonometric functions precede the unit circle definitions of these functions). There are enough applications from different fields to convince even the most skeptical student that trigonometry is really useful.

◆ New Features in the Sixth Edition

- A new **full-color design** and **expanded art program** make the book more visually appealing and pedagogically effective. Being able to "see" mathematics helps many students.
- Many new **applications** have been added and older applications have been made current. Some of the new applications **model real-world data** (e.g., Exercise 3.3, Problems 41 and 42). More **multistep applications** have been included that involve the use of concepts from preceding sections as well as concepts from the current section (e.g., Exercise 1.4, Problems 21, 22, 27, 28, 37, and 38; Exercise 1.5, Problems 31 and 32). A number of the multistep problems require the establishment of general relationships among variables and constants before specific numerical values are assigned (e.g., Exercise 1.4, Problems 21 and 22; Exercise 1.5, Problem 32).
- **Cumulative reviews** after Chapters 3, 5, and 7 are new. These review sections include problems corresponding to every chapter in the text up to that point. **Chapter summaries** now include section-by-section summaries of all important concepts and formulas. Chapter review exercise sets include many more applications. Review problems are purposely not identified by section numbers of relevant sections; however, the answers to these problems are. The inclusion of **optional sections** in the chapter reviews and in the cumulative reviews is new; this material is clearly marked with a star (☆) so that it can be omitted without loss of continuity, if desired.
- **Graphing calculator problems** are interspersed in context where appropriate throughout the book (e.g., Section 3.1, Exercise 3.1, Exercise 3.2). These problems are often exploratory in nature and are designed to add additional

insight into the concepts being developed. All graphing calculator material is identified by either a graphing calculator icon or by a "*c*" in a box and can be omitted without loss of continuity, if desired.

- **Caution** warnings, identified by an icon, alert students to potential problem areas (e.g., Sections 1.1 and 1.3).
- **Historical remarks** have been added or expanded where appropriate (e.g., Sections 1.2 and 2.1).
- **Titles** identifying the subject area or problem type have been added to examples; and the **numbering system** for examples, figures, and tables has been simplified by the start of the numbers anew in each section.

◆ Specific Changes in the Sixth Edition

Chapter 1 Right Triangle Ratios

Section 1.1 on angles, degrees, and arcs was completely rewritten. Now *angle* is defined only as a rotation. The old Section 1.2 on *significant digits* was simplified and moved to Appendix A. Section A.3, along with a table in the front endpapers of the book, guides *computational accuracy* throughout the text.

Chapter 2 Trigonometric Functions

To provide more focus, a separate subsection on *reference triangles and angles* was added to Section 2.5. Also, problems specifically on reference triangles and angles were added to Exercise 2.5. Section 2.6 on *circular functions* has been partly rewritten and expanded and more problems were added to the exercise set.

Chapter 3 Graphing Trigonometric Functions

This chapter was fine-tuned. Additional exercises and applications were added, including *modeling problems using real data* (e.g., Exercise 3.3, Problems 41 and 42). *Optional graphing calculator problems* are now distributed throughout the chapter.

Chapter 4 Identities

This chapter was fine-tuned. The process of *verifying an identity* was made more explicit. Optional graphing calculator problems are now distributed throughout the chapter.

Chapter 5 Inverse Trigonometric Functions; Trigonometric Equations

A subsection on *angle ranges in degree and radian measure* was added to Section 5.1. Problems involving degree measure were added to the exercise set. Optional graphing calculator problems are now distributed throughout the chapter.

Chapter 6 Additional Triangle Topics; Vectors

Two sections from the previous edition on the *law of sines* were completely rewritten and combined into one section. The section on the *law of cosines* was also rewritten and is now Section 6.2. The rewriting has provided *clearer strategies for solving oblique triangles,* given ASA, AAS, SSA, SAS, and SSS. There are now additional simpler applications and multistep applications for both the law of sines and the law of cosines.

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Chapter 7 Polar Coordinates; Complex Numbers
By popular demand, the *"cis" notation* was deleted from the chapter. Optional graphing calculator problems are now distributed throughout the chapter.

◆ Important Features Retained in the Sixth Edition

- The focus of this book is student comprehension. An **informal style** is used for exposition, definitions, and theorems. Precision, however, is not compromised.
- The subject matter is related to the real world through many carefully selected **realistic applications** from many different fields. These applications are uniformly distributed throughout the book.
- To gain reader interest quickly, the text moves directly into trigonometric concepts and applications. **Review material** from prerequisite courses is either integrated in certain developments (particularly in Chapters 4 and 5) or can be found in the appendixes. The material can be reviewed as needed by the student or taught in class by the instructor.
- The book includes **more than 2,000 carefully selected and graded problems**. Problems in most exercise sets are divided into A, B, and C groupings. The A problems are easy and routine, the B problems are more challenging but still emphasize mechanics, and the C problems are a mixture of more difficult mechanics and theory problems. In short, the text is designed so that an average or struggling student will be able to experience success and a very capable student will be challenged. **Answers** to most of the odd-numbered problems and almost all of the chapter and cumulative review exercises are included at the end of the book.
- The content **satisfies the requirements for many succeeding courses**, including calculus, analytic geometry, physics, and technical mathematics courses.
- The **trigonometric functions** are defined first in terms of angle domains, using degree and radian measure side by side, and then in terms of real number domains. All of this is done early in the book and is reinforced throughout. By the end of the course, students should be relatively comfortable with all three modes and should be able to shift from one to the other without difficulty.
- **Historical remarks** are included where appropriate to provide perspective (see Sections 1.1 and 1.3).

◆ Student Aids

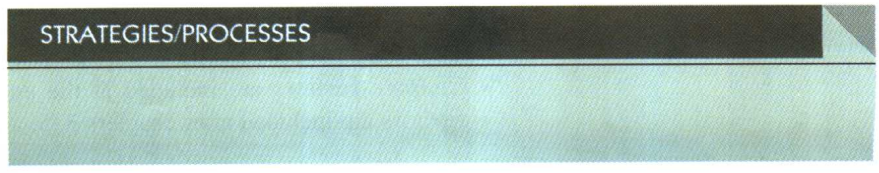
- Most concepts are illustrated by an **example** followed by a **matched problem** (with the answer near the end of the section) to encourage an active rather than passive involvement in the learning process.
- **Annotation** of examples and developments is found throughout the book to help students through critical stages (see Sections 1.2, 1.4, 4.1, 4.2, 5.3).
- **Chapter reviews** are included at the end of each chapter and **cumulative reviews** are included after chapters 3, 5, and 7.

- **Answers** to almost all chapter and cumulative review exercises and most odd-numbered problems from the other exercises are in the back of the book so that a student can easily check his or her progress.
- **Dashed "think boxes"** are used to indicate steps that are usually performed mentally after a concept or procedure is understood (e.g., Sections 1.1 and 2.4).
- **Functional use of color** guides students through critical steps and clarifies figures.
- **Generic calculator steps** are included in the early chapters of the book (e.g., Sections 1.1 and 1.3).
- **Formulas and symbols** (keyed to sections in which they are first introduced) and the metric system are summarized on the front and back endpapers of the book for convenient reference.
- A perforated **Quick Reference Card** minimizes the need for page turning by putting key equations and graphs at students' fingertips.

◆ Pedagogical Use of Color

Color is used not only to make the text more attractive, but more importantly it is used functionally to improve communications. For example, color is used in

1. Commentary that accompanies a solution process (e.g., Sections 1.3 and 4.2).
2. Graphing to visually separate the various parts of a graph (e.g., Chapters 3 and 7).
3. Boxed highlighted material to distinguish Assumptions/Definitions, Theorems, and Strategies/Processes (e.g., Sections 1.3, 4.2, and 6.5).



◆ Ancillaries

1. An **Instructor's Answer Manual** contains most of the answers that have been excluded from the text.
2. A **Student's Solutions Manual,** containing worked-out solutions to all chapter review and cumulative review exercises and all odd-numbered problems in the book, is available for students to purchase.
3. A **Trigonometry Videotape Series** reviews key topics in the text and features professional math instructors. The videotapes are free to qualified adopters; students may visit your math laboratory to view the tapes of their choice. These tutorial tapes, produced by Educational Video Resources, can significantly improve students' comprehension and performance in trigonometry.
4. **Test Items,** an improved printed and bound test bank, is available free to adopters.
5. **EXPTest** and **ExamBuilder** are improved computer-generated test systems for Windows, DOS, and Macintosh, and are available to instructors without cost.
6. A set of full-color acetate **Transparencies** depicting key concepts from trigonometry is available free to adopters.
7. **DERIVE Notebook Software** for the IBM provides students using the DERIVE computer algebra system with the opportunity to study, graph, and solve selected exercises from the text. It is available for purchase.
8. **INVESTIGATE Tutorial Software** in IBM and Macintosh formats allows students to practice the skills taught in the textbook. For topics in the text, the tutorial provides multiple-choice problems and instruction. The student is presented with solutions to incorrectly answered problems. This diagnostic program keeps track of right and wrong responses and can report to the instructor on students' progress.
9. A graphing calculator supplement, **Trigonometry Activities for the TI-82 and TI-85 Graphing Calculators** by Cynthia Dennis and Linda Neal, coordinates the use of graphing calculators with text topics in a set of exploratory learning activities that follows the organization of the text. It is available for students to purchase.

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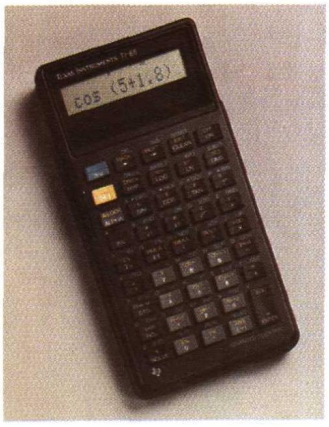
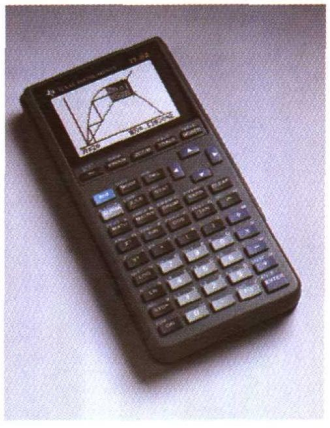
Because of the careful independent checking by three competent college mathematics instructors, the authors and publisher believe this book to be substantially error-free. If any errors remain, the authors would be grateful if corrections were sent to them care of Precalculus Editor, PWS Publishing Company, 20 Park Plaza, Boston, MA 02116-4324.

Raymond A. Barnett
Michael R. Ziegler

A NOTE ON CALCULATORS

Use of calculators is emphasized throughout this book. Many brands and types of scientific calculators are available and can be found starting at about $10. Graphing calculators are more expensive; but, in addition to having most of the capabilities of a scientific calculator, they have very powerful graphing capabilities. Your instructor should help you decide on the type and model best suited to this course and the emphasis on calculator use he or she desires.





Scientific Calculator (left) and Graphing Calculator (right)
Courtesy Texas Instruments Incorporated

Whichever calculator you use, it is essential that you read the user's manual for your calculator. A large variety of calculators are on the market, and each is slightly different from the others. Therefore, take the time to read the manual. The first time through do not try to read and understand everything the calculator can do—that will tend to overwhelm and confuse you. Read only those sections pertaining to the operations you are or will be using; then return to the manual as necessary when you encounter new operations.

In the beginning chapters of the text, calculator steps for calculations are shown. These are only aids. Try the calculation first, and then use the aid if you get stuck.

It is important to remember that a calculator is not a substitute for thinking. It can save you a great deal of time in certain types of problems, but you still must understand basic concepts so that you can interpret results obtained through the use of a calculator.

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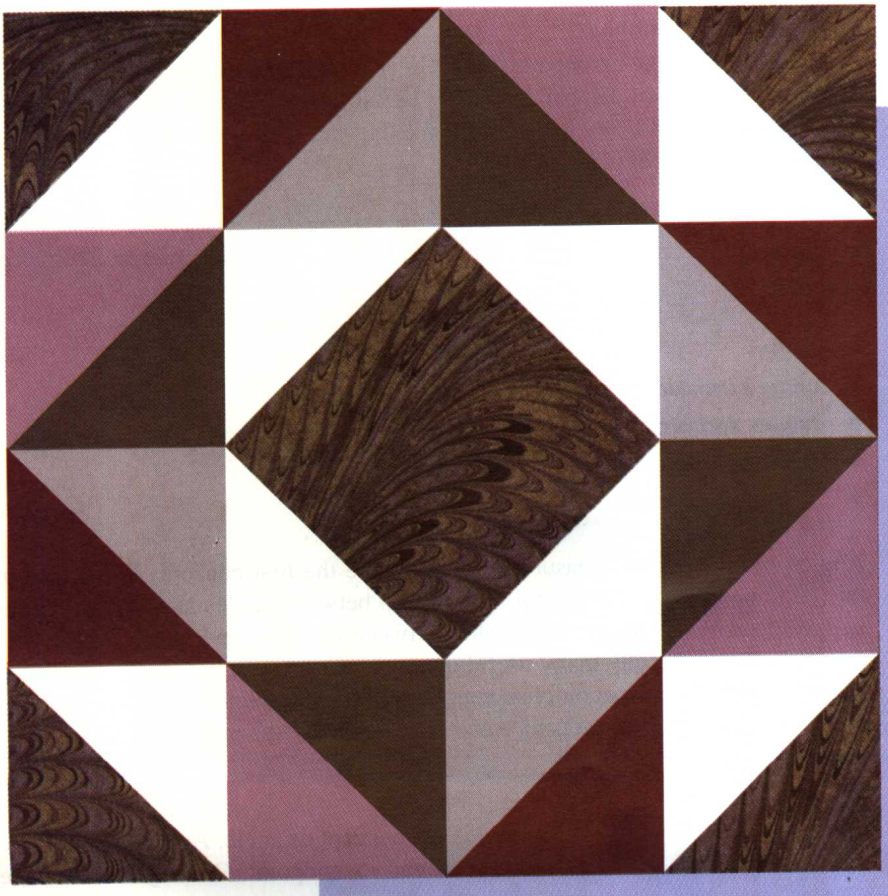
CHAPTER 1

RIGHT TRIANGLE RATIOS



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