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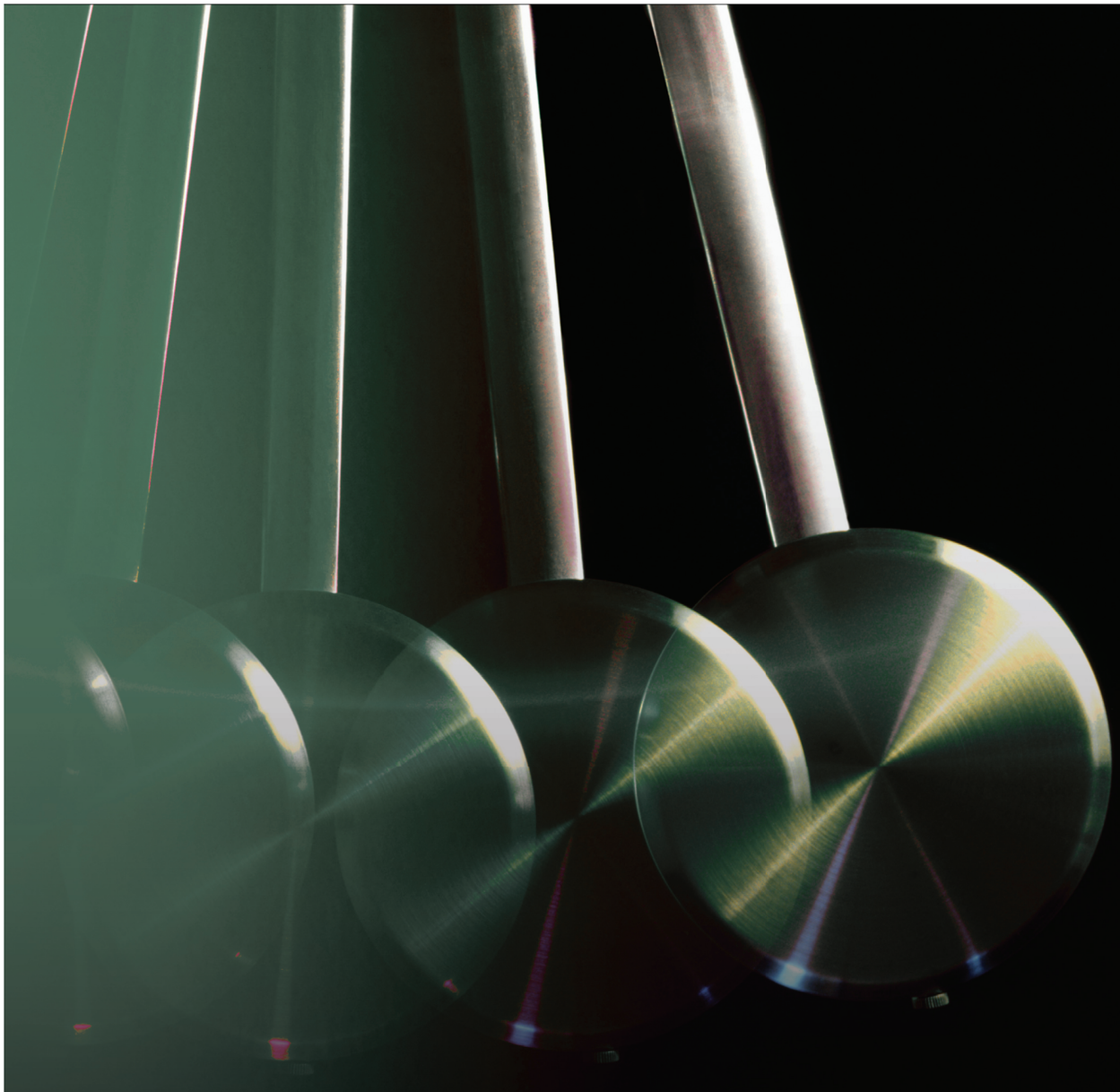

Trigonometry

Third Edition

Dennis G. Zill
Loyola Marymount University

Jacqueline M. Dewar
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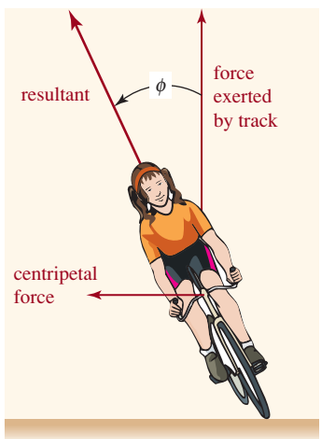

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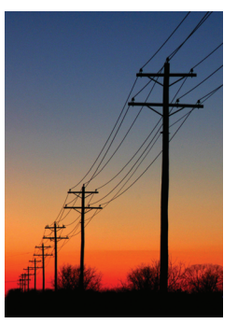

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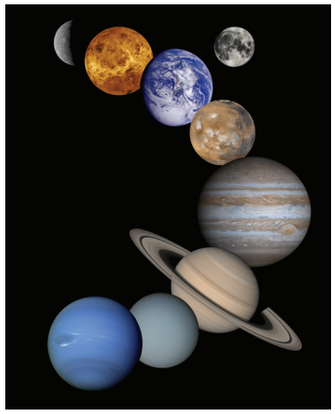

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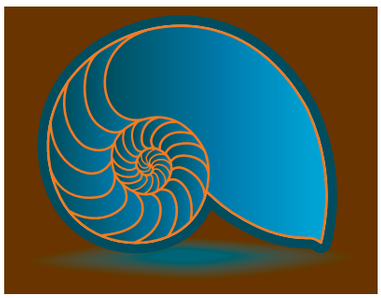

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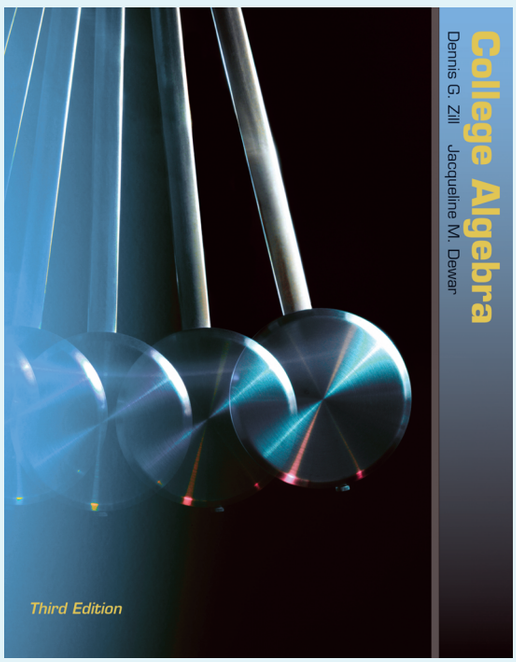

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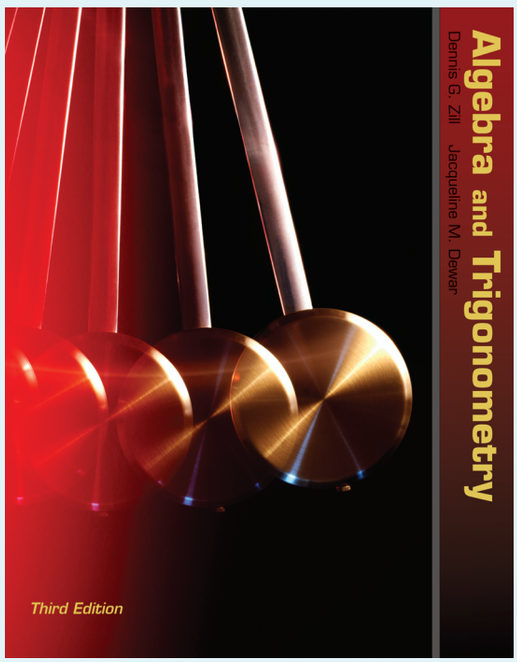

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Preface

To the Instructor

Philosophy This text reflects our philosophy that a mathematics text at the beginning college level should be readable, straightforward, and loaded with motivation. But ultimately, students can learn mathematics only by doing mathematics. Therefore, throughout this text we have place a strong emphasis on problem solving as a means of understanding. The examples are designed to motivate, instruct, and guide students. The exercises then give the students an opportunity to test their comprehension, challenge their understanding, and apply their knowledge to real-world situations.

Audience and Flexibility We intend this text to provide a treatment of trigonometry, graphs, functions, vectors, complex numbers, logarithms, analytic geometry, polar coordinates, and parametric equations that is accessible to a college student with two years of high-school mathematics. We have provided more than sufficient material for a standard one-semester or one-quarter course. This wealth of topics allows the instructor to choose those best suited to the objectives of the course and the backgrounds and abilities of the students. Thus we believe that this text can provides the prerequisites for a course in calculus.

Features in the Text

Examples It has been our experience that examples and exercises are the primary learning sources in a mathematics text. We have found that students rely on examples, not theorems and proofs. Therefore we have included numerous examples to illustrate both the theoretical concepts and the computational techniques covered in the text.

Exercises As mentioned, we feel that students can learn only by doing. Therefore, in order to promote active participation in problem-solving, the exercises are extensive and varied. The exercise sets include an abundance of drill problems, true-false questions, fill-in-the-blank questions, applications, challenging problems, graphing problems, problems that require interpretation of graphs, and discussion problems. This variety of examples gives students the opportunity to solidify their understanding of basic concepts, see practical uses for abstract mathematical ideas, and

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test their ingenuity. For this third edition we have reorganized and expanded almost all the exercise sets.

☐ **Motivation** While a number of proofs are included, we have typically motivated concepts in an intuitive or geometric manner. In addition, wherever possible we have used figures to illustrate an idea or aid in a solution.

☐ **Emphasis on Functions** Since functions are an essential concept in this course and in mathematics as a whole, we have increased the emphasis on functions, function notation, and graphical interpretation in this edition.

New to the Third Edition

☐ **Applications** In this revision we continue to provide applications culled from journals, newspapers, and scientific texts. These "real-life" problems show students the power and usefulness of the mathematics they learn in this course. The applications in this revision span a wide variety of disciplines including astronomy, biology, business, chemistry, ecology, engineering, geology, history, medicine, meteorology, optics, and physics.

☐ **Annotation Arrows** In the examples we have added many blue-colored annotation arrows within the examples and in the margin to guide the students through the various steps of the solution and to show them how concepts and properties given in theorems and definitions are used in solving a problem. Red-colored annotation arrows in the margin indicate a *Note of Caution*. These cautionary annotations indicate places in the exposition where the student should proceed slowly or even reread the text to avoid common pitfalls and misinterpretations of the material.

☐ **Chapter Openers** Each chapter now opens with its own table of contents. In addition we have provided a motivational discussion of the material and a brief historical account of one or more individuals who had influence on the development of the mathematics in the chapter.

☐ **Notes from the Classroom** Selected sections in the text conclude with informal remarks that we call *Notes from the Classroom*. These remarks are aimed directly at the student and address a wide variety of student/textbook/classroom issues such as alternative terminology, common errors, reinforcement of important concepts, what material is or is not recommended for memorization, solution procedures, use and misuse of calculators, advice on the importance of neatness and organization, misinterpretations, and an occasional word of encouragement.

☐ **Key Concepts** Each chapter concludes with a list of the topics that we feel were most important in the chapter. The students can use this as a checklist in reviewing the material for quizzes and examinations.

☐ **Chapter Review Exercises** To aid the instructor in choosing topics for review or emphasis, we have reorganized each *Chapter Review Exercises* into three distinct parts: Part A are true/false questions, Part B are fill in the blank questions, and Part C consists of traditional problems that review the important topics and concepts covered in the chapter.

Figures A word about the numbering of figures, definitions, theorems, and tables is in order. Because of the great number of figures in this text we were motivated to change to a double-decimal numeration system. For example, the interpretation of "Figure 1.2.3" is

Chapter ↓ ↓ *Section*
1 · 2 · 3 ← *Third figure in the section*

We feel that this type of numeration will make it easier to find figures, definitions, and theorems when they are referred to in later sections or chapters. In addition, to better link a figure with the text, the first textual reference to each figure is done in the same font style and color as the figure number; for example, FIGURE 1.2.3. Also, in this revision all the figures now have brief explanatory captions.

New Topics In the bulleted list that follows we indicate some of the changes made in the subject matter.

- Almost all exercise sets have been expanded with new and interesting problems. The exercise sets also contain problems called *For Discussion*. We hope that instructors will utilize these problems, which are primarily conceptual in nature, and their expertise to engage in a classroom exchange of ideas with the students on how these problems can be solved. These problems could also be the basis for assigned writing projects. To encourage original thought we purposely have not included answers to these problems.
- The discussion on finding equations of lines is now in a separate section (Section 1.4).
- Section 1.6, *Symmetry and Transformations* is new. In this section we discuss in depth the usefulness of symmetry, rigid transformations, and nonrigid transformations in obtaining the graph of a function.
- Section 1.7, *Linear and Quadratic Functions*, is also new to this edition.
- We have improved the discussion of the inverse functions (Section 1.9) by providing more motivation and clarity with several additional figures.
- Section 1.10, *Building a Function from Words*, is new to Chapter 1. We feel this material is particularly important for those students who are considering taking a subsequent course in calculus.
- The section on verification of unimportant trigonometric identities covered in Section 4.1 of the previous edition has been deleted. We feel that the learning value of such a section is questionable, especially when there are far more important topics that could be covered in greater depth.
- In this edition we focus on the applications of the important Pythagorean identities, the sum and difference formulas, double-angle formulas, and half-angle formulas.
- A new section (Section 4.5), *Simple Harmonic Motion*, has been added to Chapter 4.
- Chapter 6, *Exponential and Logarithmic Functions*, has been completely rewritten. Many new mathematical models involving these functions are considered in Section 6.4.
- The hyperbolic functions are now introduced in the new Section 6.5.
- Polar coordinates are now covered in a separate chapter (Chapter 8).
- Because of its simplicity we have added discussions on rotation of polar graphs to Chapter 8 (Sections 8.3 and 8.4).

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Lastly, all the mistakes in the text are ours. If you run across any of these errors we would greatly appreciate it if you would call them to our attention through our editor at:

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