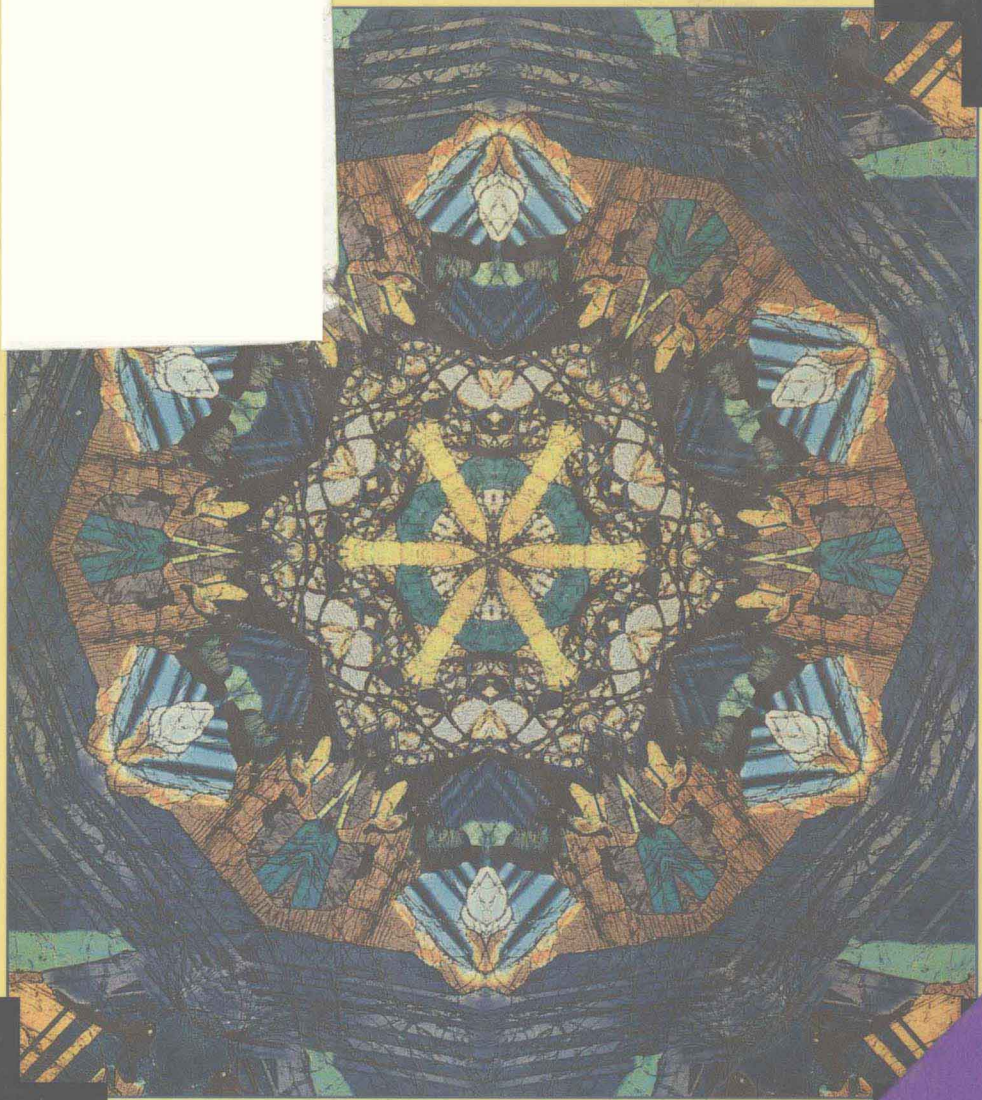
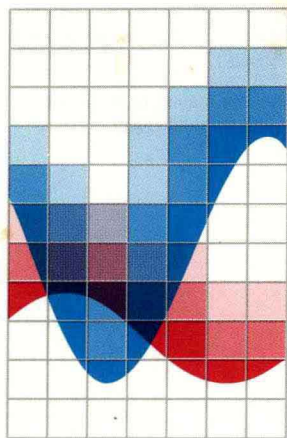


COLLEGE ALGEBRA

THIRD EDITION



Kolman Levitan
Shapiro



COLLEGE ALGEBRA

Third Edition

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To the memory of my mother, Eva.

B.K.

To my parents, Joseph and Ruth, to my daughter, Cheryl, to my son, Eric (handsome and humble like his father), to my wife, Mary Davis, and to the memory of our son, the Peruvian flash, our "beloved munchkin," Benjamin.

M.L.L.

To the memory of my mother, Helen.

A.S.

Preface

This third edition of *College Algebra* maintains our objective of providing a textbook designed for use *by the student*. The book is written in a supportive style and includes abundant pedagogic tools, described below, to encourage the student to read the text with care, follow the numerous examples and tackle the exercises. The skills and confidence the student acquires will enable him or her to succeed in more advanced mathematics courses (calculus in particular) that are required in the study of engineering, the natural sciences, business and management.

New to This Edition

At the suggestions of users and reviewers, many significant additions and improvements have been made in this edition. The order of topics has been altered slightly, a number of new topics as well as numerous exercises and figures have been added and graphics calculator material is now included. These changes are described in detail below.

Content

Several topics have been added to this edition, including an introduction to scientific notation (Section 1.6), and the critical value method for solving inequalities (Section 2.5), additional material on analytic geometry (Chapter 5), partial fractions (Section 7.4) and properties of determinants (Section 8.5).

The importance of graphing techniques is stressed throughout the text, especially in Sections 3.3 and 4.2.

Polynomial functions are discussed in Chapter 4, and this discussion includes new material on real, rational and complex zeros, and an optional section on approximation of zeros of polynomial functions.

Examples and Exercises

Many new fully worked examples have been added throughout the text to clarify and support key concepts and explanations. The exercise sets include many new exercises at all levels of difficulty. In addition, numerous applied problems from a variety of fields were written by Marilyn Belkin of Villanova University, Nina Edelman of Spring Garden College and John Santomas of Villanova University.

Cumulative Review Exercises have been added after every three chapters to help students review and prepare for examinations.

Artwork

All of the figures have been redrawn using computers to ensure accuracy. Numerous figures have been added to illustrate key concepts and new topics. Color is used pedagogically to enhance the figures as well as to highlight important concepts and definitions.

Increased Use of Technology

Because many students now have access to graphics calculators, the new graphics calculator material gives instructors a flexible approach for incorporating this technology into their course design. This material, written by Gloria Dion of Pennsylvania State University, Ogontz Campus, provides basic and advanced instructions, as well as numerous exercises. Each Graphic Calculator Alert section instructs students how to use their graphics calculator effectively. Each Power User's Corner section illustrates the special features of the graphics calculator in more advanced calculations. Over 350 exercises, marked with a special icon, give students a chance to practice using their calculators to explore essential algebra concepts graphically. For those who need more information about getting started, the appendix on graphics calculators by Gloria Dion and James Angelos of Central Michigan University discusses various graphics calculators and their value in learning algebra. This appendix includes instructions, explanations and programs for the Casio, Texas Instruments TI-81 and TI-85, and Sharp graphics calculators. *All of the graphics calculator material can be considered entirely optional.*

Pedagogic Tools

Useful features from earlier editions have been retained and enhanced, including:

- Concepts are introduced gradually, supported by fully worked examples, figures and realistic applications to help students build problem-solving skills.
- Many algebraic procedures are described with the aid of a “split screen” that displays simultaneously both the steps of an algorithm and a worked-out example.
- A “Progress Check” following many worked-out examples provides an exercise with its answer, enabling the student to test his or her understanding of the material just explained.

- Warnings reinforce good mathematical habits by pointing out incorrect practices most commonly found in homework and exams.
- Numerous vignettes have been included throughout the book. These are independent of the text yet are often related to the mathematical concepts discussed where the vignettes appear. They are intended to provide some additional interesting material for the student and instructor.
- To help students check their understanding of the concepts, each chapter concludes with a list of terms and symbols and a list of key ideas for review, all with appropriate page references. In addition, the Chapter Review Exercises and Review Tests give students a chance to practice what they have learned. The new Cumulative Review Exercises at the end of every third chapter provide additional review practice.

Exercises



Abundant, carefully graded exercises provide practice in the mechanical and conceptual aspects of algebra. Exercises requiring the use of a calculator or graphics calculator are indicated by the symbols shown in the margin. Although some exercises require student skills in graphing as well as graphics calculators, the latter may be disregarded, if desired. Answers to odd-numbered exercises, all review exercises, review tests and cumulative exercises appear in an appendix at the back of the book. Worked-out solutions to selected review exercises appear in a separate appendix at the back of the book. The solved Review Exercises reassure students that they have mastered the concepts in preparation for the Review Test.

Supplementary Material

Students using *College Algebra*, third edition, may purchase the *Study Guide and Student Solutions Manual* by Cheryl Roberts of Northern Virginia Community College. It includes complete solutions to the odd-numbered exercises, to the graphics calculator exercises and to every exercise in the Chapter Reviews, Progress Checks and Cumulative Review Exercises. In addition, each chapter of this manual begins with ten additional Practice Exercises and ends with a Chapter Test containing 20–25 exercises. Solutions to the Practice Exercises and answers to the Chapter Tests are also included.

Instructors who adopt this text may receive, free of charge, the following items:

The *Instructor's Resource Manual with Transparency Masters*, by Mohan Tikoo of Southeast Missouri State University, includes chapter-by-chapter lecture notes annotated with references to the appropriate *Algebra and Trigonometry* videotapes and transparency masters. These lecture notes also contain advice for integrating graphics calculators and graphing software programs into the course. In addition, this manual contains approximately 2500 test questions, including graphics calculator test questions, referenced by chapter and section to the text. The 100 transparency masters show the most essential figures from the text for use in classroom lectures.

The *Instructor's Solutions Manual*, by Cheryl Roberts of Northern Virginia Community College, contains complete solutions to every exercise in the text.

ExaMaster+,[™] a computerized test-preparation system is designed to accompany this text. With *ExaMaster+*[™] you can create and print a test containing any combination of questions available in the *Instructor's Resource Manual*. You can edit the existing questions and add new questions of your own, as well as create graphs and print scrambled versions of the same test. This testing package is available in both IBM® PC and MacIntosh® versions.

A & T Tutorial Software by Steven Feist is an algorithmic tutorial software program designed to create an infinite number of multiple-choice drill questions to enable students to test their understanding and problem-solving ability. *A & T Tutorial Software* is available in both IBM® PC and MacIntosh® versions.

Algebra and Trigonometry Videotapes, by Pat Stanley and Becky Bergs of Ball State University, are a twelve-tape video tutorial for the essential topics in algebra. The *Instructor's Resource Manual* references these videos to the text by chapter and section.

Acknowledgments

The authors and Saunders College Publishing wish to acknowledge the many helpful suggestions from faculty at a variety of institutions who have used the earlier editions of this book. These suggestions have strongly influenced the preparation of this edition. We look forward to continuing to receive comments and suggestions from faculty and students.

We also benefited greatly from the considered opinions of the following mathematicians who read parts or all of the initial draft of the revision:

Daniel D. Anderson	University of Iowa
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The accuracy of the solutions to the worked examples and of the answers to the Progress Checks and Exercises have been verified independently by Sudhir Goel of Valdosta State College, Norma James of New Mexico State University

and Ann Ostberg of Central Community College—Platte Campus. Although we trust that this process has increased the accuracy of the answer section as much as possible, all errors are our responsibility and we would appreciate hearing about them.

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Bernard Kolman

Drexel University

Michael L. Levitan

Villanova University

Arnold Shapiro

emeritus, Temple University

To the Student

This book was written for you, and it gives you every possible chance to succeed. We would like to have you think of mathematics as a challenging game—but not as a spectator sport. This leads to our primary rule: *Read this textbook with pencil and paper handy.* We illustrate every new idea or technique with fully worked-out examples. As you read the text, carefully follow the examples and then do the **Progress Checks**. The key to success in a math course is working problems, and the Progress Checks are there to provide immediate practice with the material you have just covered.

Your instructor will assign homework from the extensive selection of exercises that follows each section in the book. By doing many problems, you will develop the necessary skills in algebra, and your confidence will grow. Because algebraic techniques and concepts build on previous results, you cannot afford to skip any of the work.

To help prevent or eliminate improper habits and to help you avoid the errors that we see each term as we grade papers, we have interspersed **Warnings** throughout the book. These point out common errors and emphasize the correct methods to be used.

The material on calculators and graphics calculators will help you to do your homework rapidly and with greater accuracy. It will also enable you to solve realistic problems, when the numbers involved are not always “nice.”

There is important review material at the end of each chapter. The **Terms and Symbols** should all be familiar by the time you reach them. If your understanding of a term or symbol is hazy, use the page reference to find the place in the text where it is introduced, then go back and review the material.

It is possible to become so involved with the details of techniques that you lose track of the broader concepts. The list of **Key Ideas for Review** at the end of each chapter will help you focus on the principal ideas.

The **Review Exercises** at the end of each chapter can be used as part of your preparation for examinations. If you get stuck on an exercise, see if there is a

similar example worked out in the text. Alternatively, there may be a similar exercise in the Review Exercises numbered in color. This indicates that a worked-out solution appears in the back of the book. You are then ready to try the Review Test. You will soon pinpoint weak spots and you can go back for further review and more exercises in those areas.

We believe that the eventual payoff of studying mathematics is an improved ability to tackle practical problems in your field of interest. To that end, this book places special emphasis on word problems, which so often trouble students. Algebra is the bridge to all other fields of mathematics, and the mastery of algebra is well worth your effort.

Lists of Graphics Calculator Topics

The graphics calculator material has been designed to give you a flexible approach to using this technology in your course. The *Graphics Calculator Alert* sections instruct students on using a graphics calculator effectively. The *Power User's Corner* sections illustrate the special features of the graphics calculator in more advanced calculations. The lists below show the locations of these two types of boxes and the topics they cover. The *Instructor's Manual* lists the exercises requiring the use of a graphics calculator and those for which it is optional.

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