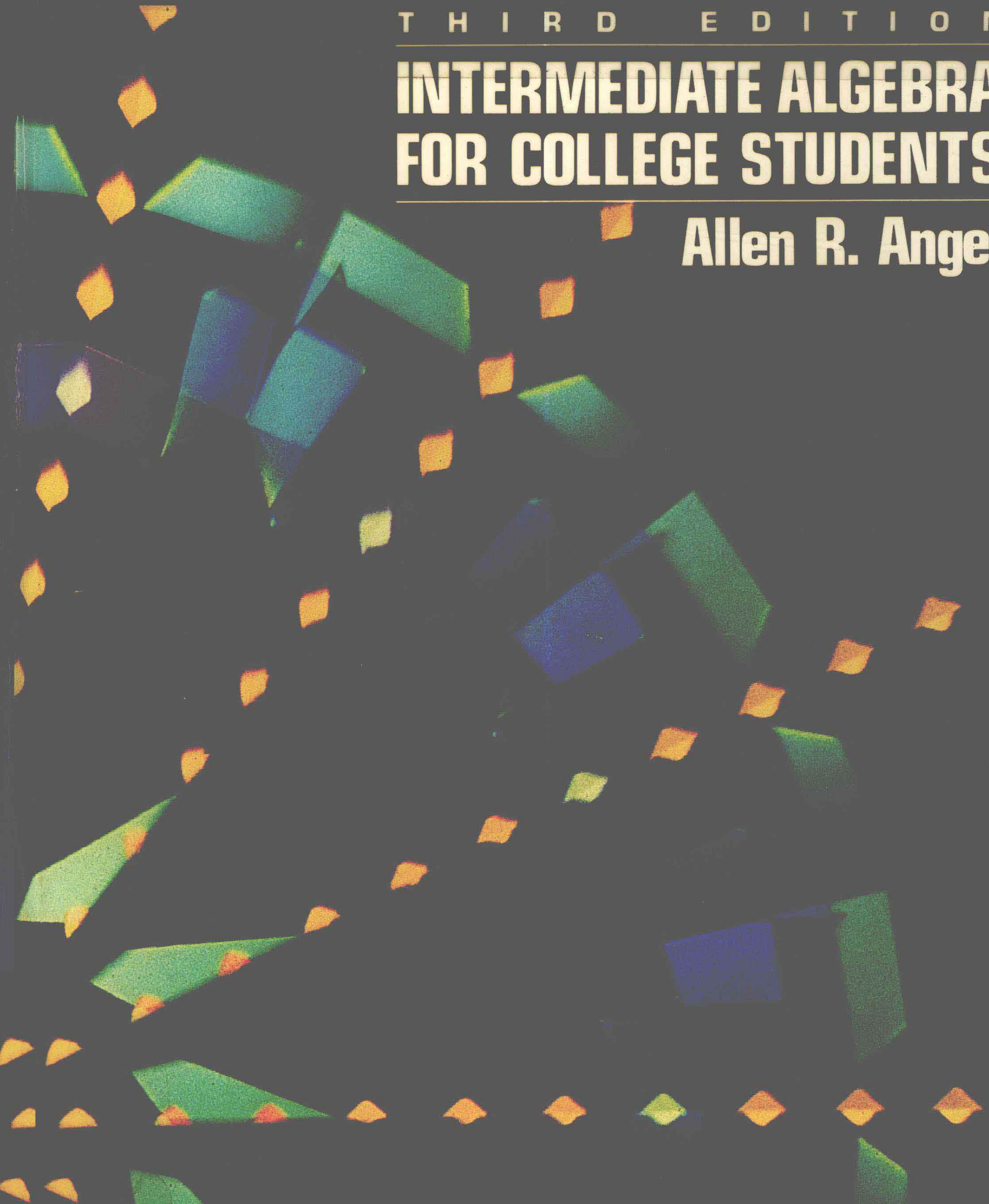
THIRD EDITION

# INTERMEDIATE ALGEBRA FOR COLLEGE STUDENTS

Allen R. Angel



THIRD EDITION

**ANNOTATED INSTRUCTOR'S EDITION**

This Annotated Instructor's Edition is exactly like your student's text, but it contains all exercise answers displayed on the same page.

# Intermediate Algebra for College Students


## Allen R. Angel

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**PRENTICE HALL**

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To my mother,
Sylvia Angel-Baumgarten

and

to the memory of my father,
Isaac Angel

# Preface

This is the second book in a two-volume algebra series. This book was written for college students who have successfully completed elementary algebra and wish to take a second course in algebra.

My primary goals in writing this book were to write a book that students could read, understand, and enjoy while acquiring the necessary skills to be successful in future mathematics courses. To achieve these goals, I have used short sentences, clear explanations, and many detailed, worked-out examples. I have tried to make the book relevant to college students by using practical applications of algebra throughout the text. For consistency in the series, I have used the same pedagogical features in this book as in *Elementary Algebra for College Students*. Some of these features are outlined below.

## Features of the Text

Four-color Format: Color is used pedagogically in the following ways:

- Important definitions and procedures are color screened.
- Color screening or color type is used to make other important items stand out.
- Errors that students commonly make are given in colored boxes as warnings for students.
- Artwork is enhanced and clarified with use of multiple colors.

Readability: One of the most important features of the text is its readability. The book is very readable, even for those with weak reading skills. Short clear sentences are used, and words that are more easily recognized and understood are used whenever possible. With so many of our students from different countries now taking algebra, this feature has become increasingly important.

Accuracy: Accuracy in a mathematics text is essential. To insure accuracy in this book, mathematicians from around the country have read the galleys carefully for typographical errors and have checked all the answers.

Spiral Approach to Learning: Many of our students do not thoroughly grasp new concepts the first time they are presented. In this text we use the spiral approach to learning. That is, we introduce a concept, then later in the text briefly reintroduce it and build upon it. Often an important concept is used in many sections of the text. Students are often reminded where the material was seen before, or where it will be used again. This also serves to emphasize the importance of the concept. Important concepts are also reinforced throughout the text in the Cumulative Review Exercises and Cumulative Review Test.

Keyed Section Objectives: Each section opens with a list of skills that the student should learn in that section. The objectives are then keyed to the appropriate portions of the sections with symbols such as ▸1.

Practical Applications: Practical applications of algebra are stressed throughout the text. Students need to learn how to translate application problems into alge-

braic symbols. The problem-solving approach used throughout this text gives students ample practice in setting up and solving application problems. The use of practical, real-life applications motivate the students.

Detailed Worked-Out Examples: A wealth of examples have been worked out in a step-by-step, detailed manner. Important steps are highlighted in color, and no steps are omitted until after the student has seen a sufficient number of similar examples.

Study Skills Section: Many students taking this course have poor study skills in mathematics. Section 1.1, the first section of this text, discusses the study skills needed to be successful in mathematics. This section should be very beneficial for your students, and should help them to achieve success in mathematics.

Common Student Errors: Errors that students often make are illustrated. The reasons why certain procedures are wrong are explained, and the correct procedure for working the problem is illustrated. These common student error boxes will help prevent your students from making those errors we see so often.

Helpful Hints: The helpful hint boxes offer useful suggestions for problem solving and other varied topics. They are set off in a special manner so that students will be sure to read them.

Calculator Corners: The Calculator Corners, placed at appropriate intervals in the text, are written to reinforce the algebraic topics presented in the section and to give students pertinent information on using the calculator to solve algebraic problems. No new algebraic information is given in the Calculator Corners.

Exercise Sets: Each exercise set is graded in difficulty. The early problems help develop the student's confidence; then the students are eased gradually into the more difficult problems. A sufficient number and variety of examples are given in the section for the student to successfully complete even the more difficult exercises. The number of exercises in each section is more than ample for student assignments and practice.

Writing Exercises: Many exercise sets now include exercises that require students to write out the answers in words. These exercises improve students understanding and comprehension of the material and help develop better reasoning and critical thinking skills. Writing exercises are indicated by the symbol ✎.

Cumulative Review Exercises: The cumulative review exercises that appear at the end of each exercise set contain questions from previous sections in the chapter and from previous chapters. These exercises will reinforce topics that were previously taught and help students retain the old material, while they are learning the new material. For the students' benefit the cumulative review exercises are keyed to the section where the material is covered.

Just for Fun Problems: At the end of many exercise sets are Just for Fun problems. These problems offer more challenging problems for the bright students in your class who want something extra. These problems present additional applications of algebra, material to be presented later in the text, or material to be covered in a later mathematics course. These exercises lend themselves nicely to group work in the classroom.

Chapter Summary: At the end of each chapter is a chapter summary which includes a glossary and important chapter facts.

Review Exercises: At the end of each chapter are review exercises that cover all types of exercises presented in the chapter. The review exercises are keyed to the sections where the material was first introduced.

Practice Tests: The comprehensive end-of-chapter practice test will enable the students to see how well they are prepared for the actual class test. The Instructor's Resource Manual includes 5 forms of each chapter test that are similar to the students' practice test (multiple-choice tests are also included in the Instructor's Resource Manual.)

Cumulative Review Tests: These tests, which appear at the end of each even-numbered chapter, test the students' knowledge of material from the beginning of the book to the end of that chapter. Students can use these tests for review, as well as for preparation for the final exam. These exams, like the cumulative review exercises, will serve to reinforce topics taught earlier.

Answers: Answers are provided to the following exercises: odd-numbered problems in the exercise sets, all cumulative review exercises, all Just for Fun exercises, all review exercises, all practice tests, and all cumulative review tests.

## Prerequisite

The prerequisite for this course is a working knowledge of elementary algebra. Although some elementary algebra topics are briefly reviewed in the text, students should have a basic understanding of elementary algebra before taking this course.

## Mode of Instruction

The format of this book lends itself to many different modes of instruction. For your students to be able to understand the material presented, the text must be readable. Short, clear sentences are used to make this text readable for students with weak reading skills. Wherever possible, common, easy-to-understand words are used.

The spiral approach, cumulative review exercises, and the cumulative review tests will continually reinforce important concepts and topics. The approach and the features of the text outlined earlier will result in greater understanding and retention of the material by your students.

The features of the text and the large variety of supplements available make this text suitable for many types of instructional modes including:

- lecture
- modified lecture
- learning laboratory
- self-paced instruction
- cooperative or group study

## Changes in the Third Edition

When I wrote the third edition, I considered the many letters and reviews I got from students and faculty. I would like to thank all of you who made suggestions for improving the third edition. I would also like to thank the many instructors and students who wrote to inform me of how much they enjoyed and appreciated the text.

Some of the changes made in the third edition of the text include:

- More detailed examples have been added throughout the book.
- More difficult exercises have been added to the graded exercises sets.
- More exercises and examples with decimal numbers and fractions have been added.
- Cumulative Review Exercises have been added to each exercise set.
- The addition of new sections on:
  - Study Skills Needed for Success in Mathematics
  - Using Factoring to Solve for a Variable in a Formula or Equation
  - Rational Exponents
  - The Algebra of Functions
  - The Natural Exponential Function and Natural Logarithms
- More and new practical applications of algebra are spread throughout the book.
- Addition of new Helpful Hints, Common Student Errors, and Calculator Corners.
- Material on linear programming has been added.
- More exercises that require written responses by students have been added.
- More problem-solving exercises have been added.
- Cumulative Review Tests have been added.
- There is a greater emphasis on the spiral approach to learning.
- Certain sections have been rewritten or reorganized for greater clarity.
- There is a general fine-tuning of the book for greater clarity.

## Supplements to the Third Edition

### *For Instructors*

*Annotated Instructor's Edition:* Includes answers to every exercise on the same page.

*Instructor's Resource Manual:* Contains solutions to even-numbered exercises and eight tests per chapter (three are multiple choice)

*PH Test Manager:* Allows users to generate tests by chapter or section number, choosing from thousands of test questions and hundreds of algorithms which generate different numbers for the same item. Editing and graphing capability are included.

*Test Item File:* Contains thousands of test items for use with PH Test Manager.

*Syllabus and Teaching Outlines (with Instructor's Disk):* Contains suggested homework assignments keyed to objectives and teaching outlines

integrating supplements into the course. All available on ASCII disk for individual customization in your course.

### *For Students*

#### Tutorial Software

*Math Master Tutor Software:* Carefully keyed to the book, with page references; includes four modes of instruction: *Explorations* (including detailed, worked-out examples with explanation); *Summary*; *Exercises* (open-ended, algorithmically generated with step-by-step solutions); and *Quiz* (with a printout option). Available free with a qualified adoption for IBM and Macintosh.

*Interactive Algebra Tutor:* An alternative, generic software with multiple choice questions, available for Apple, IBM or Macintosh. Contact College Editorial or Marketing.

*Videotapes:* Closely tied to the book, these instructional tapes feature a lecture format with worked-out examples and exercises from each section of the book. A video on study skills is also included. One master set available with each adoption of 100 or more copies.

*Student's Study Guide*. Includes additional worked-out examples, additional drill problems, and Practice Tests, and their answers. Important concepts are emphasized.

*Student's Solution Manual*. Includes detailed step-by-step solutions to odd-numbered problems in the exercise sets.

## Acknowledgments

Writing a textbook is a long and time-consuming project. Many people deserve thanks for encouraging and assisting me with this project. Most importantly I would like to thank my wife, Kathy, and sons, Robert and Steven. Without their constant encouragement and understanding, this project would not have become a reality.

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I would like to thank my students, and students and faculty from around the country, for using the second edition and offering valuable suggestions for the third edition.

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# To the Student

Algebra is a course that cannot be learned by observation. To learn algebra you must become an active participant. You must read the text, pay attention in class, and, most importantly, you must work the exercises. The more exercises you work, the better.

This text was written with you in mind. Short, clear sentences are used, and many examples are given to illustrate specific points. The text stresses useful applications of algebra. Hopefully, as you progress through the course, you will come to realize that algebra is not just another math course that you are required to take, but a course that offers a wealth of useful information and applications.

This text makes use of 4 different colors. The different colors are used to highlight important information. Important procedures, definitions, and formulas are placed within colored boxes.

The boxes marked **Common Student Errors** should be studied carefully. These boxes point out errors that students commonly make, and provide the correct procedures for doing these problems. The boxes marked **Helpful Hints** should also be studied carefully, for they also stress important information.

Ask your professor early in the course to explain the policy on when the calculator may be used. If your professor allows you to use a calculator, then pay particular attention to the **Calculator Corners.**

Other questions you should ask your professor early in the course include: What supplements are available for use? Where can help be obtained when the professor is not available? Supplements that may be available include: student's study guide, student's solutions manual, tutorial software, and video tapes, including a tape on the study skills needed for success in mathematics.

You may wish to form a study group with other students in your class. Many students find that working in small groups provides an excellent way to learn the material. By discussing and explaining the concepts and exercises to one another you reinforce your own understanding. Once guidelines and procedures are determined by your group, make sure to follow them.

One of the first things you should do is to read Section 1.1, Study Skills Needed for Success in Mathematics. Read this section slowly and carefully, and pay particular attention to the advice and information given. Occasionally, refer back to this section. This could be the most important section of the book. Carefully read the material on doing your homework and on attending class.

At the end of all exercise sets (after the first two) are **Cumulative Review Exercises.** You should work these problems on a regular basis, even if they are not assigned. These problems are from earlier sections and chapters of the book, and they will refresh your memory and reinforce those topics. If you have a problem when working these exercises, read the appropriate section of the text or study your notes that correspond to that material. The section of the text where the Cumulative Review Exercises were introduced is indicated in brackets, [ ], to the left of the exercise. After reviewing the material, if you still have a problem, make an appointment to see your professor. Working the Cumulative Review Exercises throughout the semester will also help prepare you to take your final exam.

At the end of many exercise sets are **Just for Fun** problems. These exercises are not for everyone. They are for those of you who are doing well in the course and are looking for more of a challenge. These exercises often present additional applications of algebra, material that will be presented in a later section, or material that will be presented in a later course.

At the end of each chapter are a **chapter summary,** a set of **review exercises,** and a **chapter practice test.** Before each examination you should review these sections carefully and take the practice test. If you do well on the practice test, you should do well on the class test. The questions in the review exercises are marked to indicate the section in which that material was first introduced. If you have a problem with a review exercise question turn to and reread the section indicated. You may also wish to take the **Cumulative Review Test** that appears at the end of every even-numbered chapter.

In the back of the text there is an **answer section** which contains the answers to the odd-numbered exercises, all cumulative review exercises, Just for Fun exercises, review exercises, practice tests, and cumulative review tests. The answers should be used only to check your work.

I have tried to make this text as clear and error free as possible. No text is perfect, however. If you find an error in the text, or an example or section that you believe can be improved, I would greatly appreciate hearing from you. If you enjoy the text, I would also appreciate hearing from you.

ALLEN R. ANGEL

# Contents

CHAPTER

# 1 Basic Concepts



See Section 1.5, Exercise 83.

# 1.1 Study Skills for Success in Mathematics

- ▸1 Recognize the goals of the text.
- ▸2 Prepare for class effectively.
- ▸3 Preparing for and taking examinations.
- ▸4 Determine how to find help.

You need to acquire certain study skills that will help you to successfully complete this course. These study techniques will also help you succeed in any other mathematics course you take.

## Goals of the Text

▸1 **1.** Teaching you traditional algebra topics.
**2.** Preparing you to take a more advanced mathematics course.
**3.** Building your confidence to allow you to enjoy mathematics.
**4.** Improving your reasoning and critical thinking skills.
**5.** Increasing your understanding of how important mathematics is in solving real-life problems.
**6.** Getting you to think mathematically so that you can translate a real-life problem into a mathematical equation and then solve the problem.

It is important for you to realize that this course is the foundation for more advanced mathematics courses. If you have a thorough understanding of algebra, you will find it easier to be successful in later mathematics courses.

## Have a Positive Attitude

You may be thinking to yourself, "I hate math" or "I wish I did not have to take this class." You may have heard the term "math anxiety" and feel that you fall in this category. The first thing you need to do to be successful in this course is to change your attitude to a more positive one. You must be willing to give this course and yourself a fair chance.

Based on past experiences in mathematics, you may feel this is difficult. However, mathematics is something you need to work at. Many of you taking this course are more mature now than when you took previous mathematics courses. This maturity factor and the desire to learn are extremely important and can make a tremendous difference in your ability to succeed in mathematics. I believe you can be successful in this course, but you also need to believe it.

## Prepare for Class Effectively

▸2 To be prepared for class, you need to do your homework. If you have difficulty with the homework or some of the concepts, write down questions to ask your professor. Prior to class, you should spend a few minutes previewing any new material in the textbook. At this point, you do not have to understand everything you read. Just get a feeling for the definitions and concepts that will be discussed. This quick preview will help you to understand what your instructor is explaining during class.

After the material is explained in class, read the corresponding sections of the text slowly and carefully, word by word.