

The book cover features a large, abstract design. On the left, a large, textured, reddish-brown shape curves upwards. To its right, a dark blue sky with a few white clouds is visible. A bright yellow curved line separates the sky from a dark reddish-brown area at the bottom. The title is printed in white serif font in the upper right area.

# INTERMEDIATE ALGEBRA

*With Applications*

*Second Edition*

Wesner/Nustad



# INTERMEDIATE ALGEBRA

*With Applications*

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*Second Edition*

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## Preface

*Intermediate Algebra with Applications* is designed to be used as an intermediate level text for students who have had some prior exposure to beginning algebra in either high school or college. In this second edition we have maintained our philosophy of explaining the why's of algebra, rather than simply expecting students to imitate examples. Sections are presented in such a way that, as topics progress, students realize they are actually extending properties they have already learned.

Our goal has been to make the text as easy to read as possible by presenting the material much as an instructor does in the classroom. As the title of the text indicates, we have included a cross section of applications, mainly in the exercises. These not only make the learning process more interesting for the students but also give them a reason for learning algebra.

### Problem-Solving Orientation

The skill of problem solving has been integrated throughout the text. The emphasis on problem solving begins in chapter 1 with word problems that have simple arithmetic solutions. The student learns to change word phrases into algebraic expressions. In chapter 2 and throughout the rest of the text, the student is shown how to form and solve equations from word problems.

### Pedagogical Features

**Examples** illustrate the concepts and clearly show all of the steps in solving the problem.

**Concept Boxes** include definitions, theorems, or properties along with our explanation in easy-to-understand language. The color shading makes these boxes easy for students to locate for review.

**Notes** to the students highlight important ideas and point out potential errors the students might make.

**Mastery Points** are listed before each exercise set. In essence, they are objectives for that section. They are specifically placed in this location to alert students to the particular skills they must know to successfully work the problems.

**Exercise Sets** provide abundant opportunities for students to check their understanding of the concepts being presented.

**Trial Exercise Problems** are located in the exercise sets. A trial exercise problem is denoted by a box around the problem number. This indicates that the solution is shown in its entirety at the end of the text. The trial exercise problems serve as additional examples to enhance the student's understanding of the concept or as step-by-step checks of the problems.

**Chapter Summaries** synthesize the important ideas of each chapter and are placed at the end of each chapter.

A **Chapter Review** is placed at the end of each chapter. This problem set follows the same organization as the chapter. Each problem is keyed to the section from which it was drawn. It is designed to help students determine whether they need additional study on any section of the chapter.



**Cumulative Tests** give students the opportunity to work problems that are randomly drawn from the chapter and from preceding chapters. Not only do students demonstrate their full understanding of the particular chapter, but they get to show their ability to retain information from previous chapters. If students need refreshing, they can use the section references to review the concept.

**Answers** to all problems in the chapter reviews and cumulative tests are provided in the Appendix along with answers to all the odd-numbered problems in this text.

## New to the Second Edition

1. A thorough integration of problem-solving skills throughout the text.
2. An increased emphasis on word problems with real-world applications.
3. Chapter tests have been expanded to become Cumulative Tests that provide students continual review.
4. Solving first-degree equations and inequalities has been placed in chapter 2 so students can use this knowledge when solving word problems.
5. A streamlined reorganization produces a more manageable quantity of material.

## Integrated Instructional Package of Supplements

We have assembled a comprehensive array of supplements that are fully coordinated with our text. They have been developed to complement each other in an effort to enhance both the teaching and learning aspects of this book.

### For the Instructor

The *Instructor's Manual* has been expanded to include ten challenge problems for each chapter in a form that you can photocopy to supplement your course. Five new tests (three problem solving and two multiple choice) and five final exams have been written for this edition.

**web Math TestPak** was developed expressly for this second edition. It is a free, computerized testing service with two convenient options. You may use your own Apple® IIe, IIc, Macintosh®, or IBM PC to produce your test or you may use the call-in service offered by the publisher. Contact your local **web** sales representative for details.

**web Math TestPak** is menu-driven with on-line help screens to guide you through the test-making process. You may select items from the bank, edit the existing items, add new items of your own, or have the system randomly select items for you.

The printed *Test Item File* in an 8½" × 11" format contains all of the questions on the **web Math TestPak**. It will serve as a ready-reference if you use your own computer to generate tests. The items in the *Test Item File* are different from those in the prepared tests in the *Instructor's Manual*. Hence you will have even more items to choose for your tests.

**web GradePak** is a computerized grade book that holds data for classes of up to 500 students with 60 scores per student. *GradePak* allows numeric input as well as letter grades. It is available for the IBM PC and the Apple® II family of computers.



### For the Student

The *Student's Solutions Manual* contains summaries of each section of every chapter of the text, solutions to selected odd-numbered exercise problems, and chapter self-tests with solutions. It is available for student purchase.

**web Math Tutor** is an interactive two-part computerized study guide that helps students master the text material. Part 1 includes a guided review and quiz for each section of the chapter. The objectives correspond to the mastery points in the text. Part 2 features chapter quizzes with questions randomly selected from Part 1. **web Math Tutor** is available for Apple® IIe and IIc and the IBM PC. It is free to qualified adopters and may be reproduced for computer labs or individual students.

**Math Lab** is a widely used software program developed by Chris Avery and Chris Barker of De Anza College that serves as a supplement to our text. It is based on a mastery learning approach to instruction. Students have the option to erase scores and to work new randomly generated problems until they get a perfect score. **Math Lab** provides students with immediate feedback. Through hints, it channels the student into the correct problem-solving procedure. **Math Lab** develops student confidence through successful practice. It is available for individual student purchase or laboratory use.

On the **Videotapes** the instructor introduces a concept, provides detailed explanations of example problems that illustrate the concept, including applications, and concludes with a summary. The tapes are available in ½" VHS or ¾" U-Matic format and are free to qualified adopters.

The **Audiotapes** are closely tied to the text. Here we start with a brief synopsis of the section and work out sample problems, explaining each step.

### Study tips

When you work to your full capacity, you can hope to attain the knowledge and skills that will enable you to create your future and control your destiny. If you do not, you will have your future thrust upon you by others.

*A Nation at Risk\**

There are certain study skills that you as an algebra student need to have, or develop, to assure your success in this course. In addition to the following items listed, acquaint yourself with the text by reading the preface material that precedes these study tips. Then—

1. For every hour spent in class, plan to spend at least two hours studying outside class.
2. Before going to class, read the material to be covered. This will help you more easily understand the instructor's presentation.

\*The National Commission on Excellence in Education. *A Nation at Risk*. Washington, D.C.: U.S. Government Printing Office, 1983.



3. Review the material related to each exercise set *before* attempting to work the problems. Be sure you understand the underlying concepts in the worked-out examples and the reason for each step.
4. Carefully read the instructions to the exercise set. Look at the examples and determine what is being asked. Remember, these same instructions will most likely appear on tests.
5. When working the exercise set, take your time, think about what you are doing in each step, and ask yourself why you are performing that step. As you become more confident, increase your speed to better prepare yourself for test situations.
6. When working the exercise sets, compare examples to see in what ways they are alike and in what ways they are different. Problems often *look* similar but are not.

If you do not know how to begin a problem, or you get partway through and are unable to proceed, (a) look back through your notes or (b) look for an exercise you can do that has the answer given and try to analyze the similarities. If doing these things does not work, put the problem aside. Often getting away from it for a time will “open the door” when you try it again. Finally, if you need to, consult your instructor and show him/her the work you have done.

The fact that you will be “using tomorrow what you are doing today” makes it imperative that you learn each concept as you go along. Most concepts, especially the ones that give you the most difficulty, need constant review.

The practice of checking your work will aid you in two ways:

1. It will develop confidence, knowing you have done the problem correctly.
2. It will help you discover your errors on an exam that might otherwise have gone undetected had you not checked your work.

When checking your work, use a different method from the one you used to solve the problem. If the same procedure is used, a tendency to make the same mistake exists. Develop methods for checking your work as you do the practice exercises. This checking then becomes automatic when taking a test.

The following hints will aid you in preparing for an exam:

1. Begin studying and reviewing a number of days prior to the exam. This will enable you to contact your instructor for help if you need it. “All-night” sessions the night before the exam seldom (if ever) yield good results.
2. Take periodic breaks—10 to 15 minutes for each hour of study. Study for no longer than four hours at a time.
3. Work to develop understanding as well as skills. Memorization is seldom useful in an algebra course, so concentrate on understanding the methods and concepts. However do not ignore skill development, since doing so can often lead to what students call “stupid mistakes.”



Prior to taking an exam, use the exercise sets, chapter reviews, and/or *Student's Solutions Manual* to make out a practice test, determine where your errors lie, and retake the test to be sure that you have corrected the mistakes. Allot the same amount of time you will be allowed on test day.

When taking the algebra exam you should:

1. Look over the exam to locate the easiest problems.
2. Work these problems first.
3. Work the more difficult and time-consuming problems next. Remember, when stuck on a problem, go on to other problems and return to those giving you difficulty *only after* completing all that you can.
4. Use what time remains to check your answers or to rework those problems that you found most difficult.

Don't panic should you "draw a blank." Avoid thoughts of failure. Should you feel this happening, relax and try to clear your mind. Search out the problems you feel most confident about and begin again. Should you be unable to complete the exam, be sure to check the problems that you have completed. Always be aware of the time remaining. *Do not hurry* and do not be intimidated by other students completing the exam early.

One final bit of advice. Show your work neatly. Develop this habit when working on your practice problems. There is a close correlation between neatly laid-out work and the correct answer. Your instructor will appreciate this and be more inclined to give you more credit if the answer is wrong.

## Acknowledgments

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Throughout the development, writing, and production of this text, three people have been of such great value that we are truly indebted to them for their excellent work on our behalf. We wish to express our utmost thanks to Suresh Ailawadi, Eugenia M. Collins, and Nova A. Maack.



## **Error Check**

Because of the careful proofreading and checking of all the examples and answers by a large number of very competent people working independently, the authors and the publisher believe this book to be virtually error-free. We wish to express our sincere thanks to Suresh Ailawadi, Terry Baker, Donald Bellairs, Harry Datsun, Bruce Harold, Lisa Miyazaki, and John Snyder. Their hard work is greatly appreciated.

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INTERMEDIATE  
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# Chapter 1

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## Basic Concepts and Properties

### 1-1 Sets and real numbers

#### Set symbolism

We begin our study with a very simple, but important, mathematical concept—the idea of a **set**.\* *A set is any collection of objects or things.* We want the sets that we deal with to be *well defined*; that is, given any object, we can determine whether the object is in a given set. For example, the set of old people is not well defined because the meaning of old is not clear. Whereas the set of people whose ages are greater than seventy years is a well-defined set. In mathematics the idea of a set is used primarily to denote a group of numbers or the set of answers to a problem.

Any one of the things that make up a set is called a **member** or an **element** of that set. One way of writing a set is by listing the elements, separating them by commas, and including this listing within a pair of braces, { }. This way of representing a set is called the **listing** or **roster method**.

\*George Cantor (1845–1918) is credited with the development of the ideas of set theory. He described a set as a grouping together of single objects into a whole.