Instructor's Annotated Edition

INTERMEDIATE ALGEBRA WITH APPLICATIONS

5th Edition

Aufmann | Barker | Lockwood

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Intermediate Algebra

with Applications

Fifth Edition

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PREFACE

The fifth edition of *Intermediate Algebra with Applications* provides a mathematically sound and comprehensive coverage of the topics considered essential in an intermediate algebra course. The text has been designed not only to meet the needs of the traditional college student but also to serve the needs of returning students whose mathematical proficiency may have declined during their years away from formal education.

In this new edition of *Intermediate Algebra with Applications,* careful attention has been given to implementing the standards suggested by NCTM and AMATYC. Each chapter begins with a mathematical vignette consisting of an application, a historical note, or a curiosity related to mathematics as well as a career note. At the end of each section there are Applying Concepts exercises that include writing, synthesis, critical thinking, and challenge problems. The chapter ends with Focus on Problem Solving and Projects and Group Activities. The Focus on Problem Solving feature demonstrates various proven problem-solving strategies and then asks the student to use the strategies to solve problems. The Projects and Group Activities feature extensions or applications of a concept that was covered in the chapter. These projects can be used for cooperative learning activities or extra credit.

Instructional Features

Interactive Approach

Intermediate Algebra with Applications uses an interactive style that gives the student an opportunity to try a skill as it is presented. Each section is divided into objectives, and every objective contains one or more sets of matched-pair examples. The first example in each pair is worked out; the second example, labeled Problem, is for the student to work. By solving this problem, the student practices using concepts as they are presented in the text. There are *complete* worked-out solutions to these problems in a Solutions section at the end of the book. By comparing their solutions to model solutions, students can get immediate feedback on and reinforcement of the concepts.

Emphasis on Problem-Solving Strategies

Intermediate Algebra with Applications features a carefully sequenced approach to application problems that emphasizes using proven strategies to solve problems. Students are encouraged to develop their own strategies, to draw diagrams, and to write their strategies as part of the solution to each application problem. In each case, model strategies are presented as guides for students to follow as they attempt the matched-pair Problem.

Emphasis on Applications

The traditional approach to teaching algebra covers only the straightforward manipulation of numbers and variables and thereby fails to teach students the practical

value of algebra. By contrast, *Intermediate Algebra with Applications* contains an extensive collection of contemporary application problems. Wherever appropriate, the last objective of a section presents applications that require the student to use the skills covered in that section to solve practical problems. This carefully integrated, applied approach generates awareness on the student's part of the value of algebra as a real-life tool.

Integrated Learning System Organized by Objectives

Each chapter begins with a list of the learning objectives included within that chapter. Each objective is then restated in the chapter to remind the student of the current topic of discussion. The same objectives that organize the text are reflected in the structure for exercises, for the testing programs, and for the HM³ Tutorial. Associated with every objective in the text is a corresponding computer tutorial and a corresponding set of test questions.

The Interactive Approach

Instructors have long recognized the need for a text that requires the student to use a skill as it is being taught. *Intermediate Algebra with Applications* uses an interactive technique that meets this need. Every objective, including the one shown below, contains at least one pair of examples. One of the examples is worked.

An explanatory passage begins each skill objective.

Paired examples follow the explanatory passage.

The Problem is the key to the interactive approach. It has not been worked so that the student may practice the skill, referring to the worked example above if necessary.

Reference to the page where the problem is solved in the Solutions section allows the student to check solutions immediately.

SECTION 6.1

Introduction to Rational Functions

1 Find the domain of a rational function

An expression in which the numerator and denominator are polynomials is called a **rational expression.** Examples of rational expressions are shown at the right.

$\frac{9}{z}$ $\frac{3x+4}{2x^2+1}$ $\frac{x^3-x+1}{x^2-3x-5}$

The expression $\frac{\sqrt{x}+3}{x}$ is not a rational expression because $\sqrt{x}+3$ is not a polynomial.

A function that is written in terms of a rational expression is a **rational function.** Each of the following equations represents a rational function.

$f(x)=\frac{x^2+3}{2x-1}$ $g(t)=\frac{3}{t^2-4}$ $R(z)=\frac{z^2+3z-1}{z^2+z-12}$

To evaluate a rational function, replace the variable by its value. Then simplify.

Example 1 Given $f(x)=\frac{3x-4}{x^2-2x+1}$, find $f(-3)$.

Solution

$f(x)=\frac{3x-4}{x^2-2x+1}$

$f(-3)=\frac{3(-3)-4}{(-3)^2-2(-3)+1}$ ▸ Substitute −3 for x.

$f(-3)=\frac{-9-4}{9+6+1}$

$f(-3)=\frac{-13}{16}$

$f(-3)=-\frac{13}{16}$

Problem 1 Given $f(x)=\frac{3-5x}{x^2+5x+6}$, find $f(2)$.

Solution See page S16.

The second example in the pair (the Problem) is not worked so that the student may "interact" with the text by solving it. In order to provide immediate feedback, a complete solution to this Problem is provided in the Solutions section. The benefit of this interactive style is that students can check whether they have learned the new skill before they attempt a homework assignment.

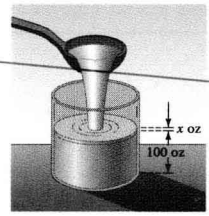
Emphasis on Applications

The solution of an application problem in *Intermediate Algebra with Applications* comprises two parts: **Strategy** and **Solution**. The strategy is a written description of the steps that are necessary to solve the problem; the solution is the implementation of the strategy. Using this format provides students with a structure for problem solving. It also encourages students to write strategies for solving problems, which in turn fosters their organizing problem-solving strategies in a logical way. Having students write strategies is a natural way to incorporate writing into the math curriculum.

A strategy that the student may use in solving an application problem is stated.

This strategy is used in the solution of the worked example.

When students compare their solutions to those in the Solutions section, they will see a complete solution of the problem along with a written strategy for solving the problem.



Example 1 How many ounces of a gold alloy that costs \$320 an ounce must be mixed with 100 oz of an alloy that costs \$100 an ounce to make a mixture that costs \$160 an ounce?

Strategy

- Ounces of the \$320 gold alloy: x

	Amount	Cost	Value
\$320 alloy	x	320	$320x$
\$100 alloy	100	100	100(100)
Mixture	$x + 100$	160	$160(x + 100)$

- The sum of the values before mixing equals the value after mixing.

Solution

$$320x + 100(100) = 160(x + 100)$$
$$320x + 10{,}000 = 160x + 16{,}000$$
$$160x + 10{,}000 = 16{,}000$$
$$160x = 6000$$
$$x = 37.5$$

The mixture must contain 37.5 oz of the \$320 gold alloy.

Problem 1 A butcher combined hamburger that costs \$3.00 per pound with hamburger that costs \$1.80 per pound. How many pounds of each were used to make a 75-pound mixture that costs \$2.20 per pound?

Solution See page S3.

SECTION 2.3

Problem 1

Strategy

- Pounds of \$3.00 hamburger: x
  Pounds of \$1.80 hamburger: $75 - x$

	Amount	Cost	Value
\$3.00 hamburger	x	3.00	$3.00x$
\$1.80 hamburger	$75 - x$	1.80	$1.80(75 - x)$
Mixture	75	2.20	75(2.20)

- The sum of the values before mixing equals the value after mixing.

Solution

$$3.00x + 1.80(75 - x) = 75(2.20)$$
$$3x + 135 - 1.80x = 165$$
$$1.2x + 135 = 165$$
$$1.2x = 30$$
$$x = 25$$

$$75 - x = 75 - 25 = 50$$

The mixture must contain 25 lb of the \$3.00 hamburger and 50 lb of the \$1.80 hamburger.

The Objective-Specific Approach

Many texts in mathematics are not organized in a manner that facilitates management of learning. Typically, students are left to wander through a maze of apparently unrelated lessons, exercise sets, and tests. *Intermediate Algebra with Applications* solves this problem by organizing all lessons, exercises sets, computer tutorials, and tests around a carefully constructed hierarchy of objectives. The advantage of this objective-by-objective organization is that it enables the student who is uncertain at any step in the learning process to refer easily to the original presentation and review that material.

The objective-specific approach also gives the instructor greater control over the management of student progress. The computerized testing program and the

An objective statement names the topic of each lesson.

SECTION **2.5**

Inequalities in One Variable

1 Solve inequalities in one variable

The exercise sets correspond to the objectives in the text.

EXERCISES 2.5

1 **1.** **a.** What does the Addition Property of Inequalities state?
b. When is the Addition Property of Inequalities used?

2. **a.** What does the Multiplication Property of Inequalities state?
b. When is the Multiplication Property of Inequalities used?

The answers to the odd-numbered exercises are provided in the Answer section.

SECTION 2.5

3. $\{x|x<5\}$ **5.** $\{x|x\le 2\}$ **7.** $\{x|x<-4\}$ **9.** $\{x|x>3\}$ **11.** $\{x|x>4\}$ **13.** $\{x|x>-2\}$
15. $\{x|x\ge 2\}$ **17.** $\{x|x\le 3\}$ **19.** $\{x|x<-3\}$ **21.** $(-\infty,5]$ **23.** $[1,\infty)$ **25.** $(-\infty,-5)$
27. $\left(-\infty,\frac{23}{16}\right)$ **29.** $\left[\frac{8}{3},\infty\right)$ **31.** $(-\infty,1)$ **33.** $(-\infty,3)$ **35.** $(-1,2)$ **37.** $(-\infty,1]\cup[3,\infty)$
39. $(-2,4)$ **41.** $(-\infty,-3)\cup(0,\infty)$ **43.** $[3,\infty)$ **45.** $\varnothing$ **47.** $\varnothing$ **49.** $(-\infty,1)\cup(3,\infty)$

The answers to the Chapter Review Exercises, the Chapter Test, and the Cumulative Review Exercises show the objective to study if the student incorrectly answers the exercise.

CHAPTER REVIEW EXERCISES

1. -9 (Obj. 2.1.1) **2.** $-\frac{1}{12}$ (Obj. 2.1.1) **3.** 7 (Obj. 2.1.1) **4.** $\frac{2}{3}$ (Obj. 2.1.1) **5.** $\frac{8}{5}$ (Obj. 2.1.1)
6. 6 (Obj. 2.1.1) **7.** $\frac{26}{17}$ (Obj. 2.1.2) **8.** $\frac{5}{2}$ (Obj. 2.1.2) **9.** $-\frac{17}{2}$ (Obj. 2.1.2)

CHAPTER TEST

1. -2 (Obj. 2.1.1) **2.** $-\frac{1}{8}$ (Obj. 2.1.1) **3.** $\frac{5}{6}$ (Obj. 2.1.1) **4.** 4 (Obj. 2.1.1) **5.** $\frac{32}{3}$ (Obj. 2.1.1)
6. $-\frac{1}{5}$ (Obj. 2.1.1) **7.** 1 (Obj. 2.1.2) **8.** -24 (Obj. 2.1.2) **9.** $\frac{12}{7}$ (Obj. 2.1.2)
10. $(-\infty,-3]$ (Obj. 2.5.1) **11.** $(-1,\infty)$ (Obj. 2.5.1) **12.** $\{x|x>-2\}$ (Obj. 2.5.2)

CUMULATIVE REVIEW EXERCISES

1. -108 (Obj. 1.2.3) **2.** 3 (Obj. 1.2.4) **3.** -64 (Obj. 1.2.4) **4.** -8 (Obj. 1.3.2) **5.** The Commutative Property of Addition (Obj. 1.3.1) **6.** $\{3,9\}$ (Obj. 1.1.2) **7.** $-17x+2$ (Obj. 1.3.3) **8.** $25y$ (Obj. 1.3.3)
9. 2 (Obj. 2.1.1) **10.** $\frac{1}{2}$ (Obj. 2.1.1) **11.** 1 (Obj. 2.1.1) **12.** 24 (Obj. 2.1.1) **13.** 2 (Obj. 2.1.2)
14. 2 (Obj. 2.1.2) **15.** $-\frac{13}{5}$ (Obj. 2.1.2) **16.** $\{x|x\le -3\}$ (Obj. 2.5.1) **17.** $\varnothing$ (Obj. 2.5.2)

printed testing program are organized in terms of the same objectives as the text. These references are provided with the answers to the test items. This allows the instructor to identify quickly those objectives for which a student may need additional instruction.

The HM³ Tutorial is also organized around the objectives of the text. As a result, supplemental instruction is available for any objectives that are troublesome for a student.

Features of This Edition

Topical Coverage

Intermediate Algebra with Applications carefully integrates a balance of applications and skill development to help students understand the connection between mathematics and its application. The concept of function is developed early in the text and is used in a variety of situations as a model of how one quantity depends on another. Examples of polynomial, exponential, and logarithmic functions are presented at appropriate times in the text.

The application problems in the text are diverse and contemporary. We have included applications from business, sports, economics, and medicine to name but a few. Many of these applications are new and include topics not included in earlier editions. A complete list of the applications can be found in the Index of Applications.

Margin Notes

There are two types of margin notes in the student text. *Point of Interest* notes feature interesting sidelights of the topic being discussed. The *Look Closely* feature warns students that a procedure may be particularly involved or reminds students that there are certain checks of their work that should be performed. In addition, there are *Instructor Notes* that are printed only in the Instructor's Annotated Edition. These notes provide suggestions for presenting the material or related material that can be used in class.

Study Tips

Effective study skills are an important factor in achieving success in any discipline. This is especially true in mathematics. To help students acquire these skills, we offer Study Tips boxes throughout the first few chapters of the text. Each box contains a suggestion that will lead to improved study habits.

Focus on Problem Solving

Although successful problem solvers use a variety of techniques, it has been well established that there are basic recurring strategies. Among these are trying to solve a related problem, finding a counterexample, trying to solve an easier problem, working backwards, and trial and error. The Focus on Problem Solving features present some of these methods in the context of a problem to be solved. Students are encouraged to apply these strategies in solving similar problems.

Projects and Group Activities

The Projects and Group Activities appear near the end of each chapter. These projects can be used for extra credit or as cooperative learning activities. Through these projects, some of the strategies suggested by AMATYC can be implemented. These projects offer an opportunity for students to explore topics relating to functions, geometry, statistics, science, and business.

HM^3 Tutorial

This state-of-the-art tutorial software is a networkable, interactive, algorithmically driven software package that supports *every* objective in the text. Written by the authors, the HM^3 Tutorial and the text are in the same voice. Features include full-color graphics, a glossary, extensive hints, animated examples, and a comprehensive classroom management system.

The algorithmic feature essentially provides an infinite number of practice problems for students to attempt. The algorithms have been carefully crafted to present a variety of problem types from easy to difficult. Helpful hints and a complete worked-out solution are available for every problem. When a student completes a problem, there is an option to repeat a similar problem or to move on to another type of problem. A quiz feature is now also part of the package.

The interactive feature asks students to respond to questions about the topic in the current lesson. In this way, students can assess their understanding of concepts as they are presented. These interactive questions are also algorithmically driven and offer hints as well as a full solution.

The user-friendly classroom management system allows instructors to create a syllabus, post notes to individual students or a class, enter their own assessment items (i.e., homework, class participation, etc.), and choose the mastery level. There are a variety of printable reports offered; these can be called up by student, by class, by objective, etc., and many reports will tell at a glance which students are not achieving the mastery level the instructor specified.

Index of Applications

The Index of Applications that follows the Preface provides a quick reference for application problems from a wide variety of fields.

Graphing Calculators

Graphing calculators are incorporated as an optional feature at appropriate places throughout the text. Graphing calculator material is designated by the graphing calculator icon shown at the beginning of this paragraph. The graphing calculator may help some students as they struggle with new concepts. However, all graphing calculator material can be omitted without destroying the integrity of the course. Students can consult the appendix, Guidelines for Using Graphing Calculators, for help with keystroking procedures for several models of graphing calculators.

Chapter Summaries

The Chapter Summaries have been written to be a useful guide for students as they review for a test. The Chapter Summary includes the Key Words and the Essential Rules and Procedures that were covered in the chapter. Each key word and essential rule is accompanied by an example of that concept.

Glossary

There is a Glossary that includes definitions of terms used in the text.

Exercises

End-of-Section Exercises

Intermediate Algebra with Applications contains more than 6000 exercises. At the end of each section there are exercise sets that are keyed to the corresponding learning objectives. The exercises have been carefully developed to ensure that students can apply the concepts in the section to a variety of problem situations.

Concept Review Exercises

These "Always true, Sometimes true, or Never true" exercises precede every exercise set and are designed to test a student's understanding of the material. Using Concept Review exercises as oral exercises at the end of a class session can lead to interesting class discussions.

Applying Concepts Exercises

The end-of-section exercises are followed by Applying Concepts exercises. These contain a variety of exercise types:

- Challenge problems (designated by [C] in the Instructor's Annotated Edition only)
- Problems that ask students to interpret and work with real-world data
- Writing exercises
- Problems that ask students to determine incorrect procedures
- Problems that require a more in-depth analysis

Data Exercises

These exercises, designated by  , ask students to analyze and solve problems taken from actual situations. Students are often required to work with tables, graphs, and charts drawn from a variety of disciplines.

Writing Exercises

Writing exercises, denoted by  , occur at the beginning of many exercise sets and within Applying Concepts exercises. These exercises ask students to write

about a topic in the section or to research and report on a related topic. There are also writing exercises in some of the application problems. These exercises ask students to write a sentence that describes the meaning of their answers in the context of the problem.

Chapter Review Exercises and Chapter Tests

Chapter Review Exercises and a Chapter Test are found at the end of each chapter. These exercises are selected to help the student integrate all the topics presented in the chapter. The answers to all Chapter Review and Chapter Test exercises are given in the Answer section. Along with the answer, there is a reference to the objective that pertains to each exercise.

Cumulative Review Exercises and Final Exam

Cumulative Review Exercises, which appear at the ends of Chapters 2–11, help the student maintain skills learned in previous chapters. In addition, a Final Exam appears at the end of Chapter 12. The answers to all Cumulative Review and Final Exam exercises are given in the Answer section. Along with the answer, there is a reference to the objective that pertains to each exercise.

New to This Edition

The sequence of chapters has been slightly changed so as to allow a better pedagogical organization. The chapter on *Rational Expressions,* which requires a lot of factoring, is now Chapter 6, and immediately follows Chapter 5, *Polynomials and Exponents,* where factoring is introduced. The chapter on *Rational Exponents and Radicals* is now Chapter 7, which lends support to Chapter 8, *Quadratic Equations and Inequalities.*

Functions are still introduced in Chapter 3, *Linear Functions and Inequalities in Two Variables,* but the material, which many students find difficult to grasp, has been expanded to include more detailed explanations. In particular, a more detailed and illustrated definition of domain and range has been added.

The calculator material within the exposition has been expanded. We have given more prominence to the in-text calculator commentary by boxing this material and identifying it with an icon.

We have more than doubled the number of projects found at the end of each chapter. In addition, those projects involving calculators and internet sites have been marked for easy identification with the appropriate icon. Graph interpretation exercises have also been added to the projects.

Career notes and photos have been added to the chapter openers to illustrate to students the diverse ways in which mathematics is used in the workplace.

In response to suggestions by users, the writing and data icons appear in the student text as well as in the instructor's edition. We have also integrated writing exercises within the exercise sets rather than limit them to the Applying Concepts section of the exercises.

All the real sourced data exercises and examples have been updated, and many new data problems have been added. We have also titled application exercises to help motivate student interest.

To be consistent with our objective-specific approach, we have expanded the Table of Contents to include objective statements.

Supplements for the Instructor

Instructor's Annotated Edition

The Instructor's Annotated Edition is an exact replica of the student text except that answers to all exercises are given in the text. Also, there are Instructor Notes in the margins that offer suggestions for presenting the material in that objective.

Instructor's Resource Manual with Solutions Manual

The Instructor's Resource Manual includes suggestions for course sequencing and gives sample answers for the writing exercises. The Solutions Manual contains worked-out solutions for all end-of-section exercises, Concept Review exercises, Focus on Problem Solving exercises, Projects and Group Activities, Chapter Review exercises, Chapter Test exercises, Cumulative Review exercises, and Final Exam exercises.

Computerized Test Generator

The Computerized Test Generator is the first of three sources of testing material. The database contains more than 2000 test items. These questions are unique to the Test Generator. The Test Generator is designed to provide an unlimited number of chapter tests, cumulative chapter tests, and final exams. It is available for Microsoft Windows® and the Macintosh. Both versions provide **algorithms, online testing,** and **gradebook** functions.

Printed Test Bank with Chapter Tests

The Printed Test Bank, the second component of the testing material, is a printout of all items in the Computerized Test Generator. Instructors who do not have access to a computer can use the test bank to select items to include on tests prepared by hand. The Chapter Tests comprise the printed testing program, which is the third source of testing material. Eight printed tests, four free-response and four multiple-choice, are provided for each chapter. In addition, there are cumulative tests for use after Chapters 3, 6, 9, and 12, and a final exam.

Supplements for the Student

Student Solutions Manual

The *Student Solutions Manual* contains complete solutions to all odd-numbered exercises in the text.

HM³ Tutorial

The content of this new interactive state-of-the-art tutorial software was written by the authors and is in the same voice as the text. The HM³ Tutorial supports every objective in the text. Problems are algorithmically generated; lessons provide animated examples; lessons and problems are presented in a colorful, lively manner; and an integrated classroom management system tracks and reports student performance. Features include:

- assessment
- free-response problems
- ability to repeat same problem type
- printing capability
- glossary
- resizable screen
- pedagogical animations
- interactivity within lessons
- algorithms
- extensive classroom management with syllabus customization and a variety of reports

The HM³ Tutorial can be used in several ways: (1) to cover material the student missed because of absence; (2) to reinforce instruction on a concept that the student has not yet mastered; (3) to review material in preparation for exams; and (4) for self-instruction.

This networkable HM³ Tutorial is available on CD-ROM for Windows. There is also an alternate version offered for the Macintosh, available only on floppy disk. The HM³ Tutorial is free to any school upon adoption of this text; however, students can purchase a non-networkable copy of the HM³ Tutorial for home use.

Within each section of the book, a computer disk icon 

appears next to each objective. The icon serves as a reminder that there is an HM³ Tutorial lesson corresponding to that objective.

Videotapes

The videotape series contains lessons that accompany *Intermediate Algebra with Applications.* These lessons follow the format and style of the text and are closely tied to specific sections of the text. Each videotape begins with an application, and then the mathematics needed to solve that application is presented. The tape closes with the solution of the application problem.

 Within each section of the book, a videotape icon appears next to each objective that is covered by a videotape lesson.

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