Introductory
Algebra

ANNOTATED INSTRUCTOR’S EDITION

Marvin L. Bittinger
Indiana University Purdue University Indianapolis

Judith A. Beecher
Indiana University Purdue University Indianapolis

Barbara L. Johnson
Indiana University Purdue University Indianapolis

Pearson
### Systems of Equations

- **7.1** Systems of Equations in Two Variables 536
- **7.2** The Substitution Method 543
- **7.3** The Elimination Method 550

#### Mid-Chapter Review 558
- **7.4** Applications and Problem Solving 560
- **7.5** Applications with Motion 571

#### Translating for Success 575
- **7.6** Summary and Review 578
- **Test 583**
- **Cumulative Review 585**

### Radical Expressions and Equations

- **8.1** Introduction to Radical Expressions 588
- **8.2** Multiplying and Simplifying with Radical Expressions 596
- **8.3** Quotients Involving Radical Expressions 604

#### Mid-Chapter Review 611
- **8.4** Addition, Subtraction, and More Multiplication 613
- **8.5** Radical Equations 621
- **8.6** Applications with Right Triangles 629

#### Translating for Success 632
- **8.7** Summary and Review 635
- **Test 641**
- **Cumulative Review 643**

### Quadratic Equations

- **9.1** Introduction to Quadratic Equations 646
- **9.2** Solving Quadratic Equations by Completing the Square 654
- **9.3** The Quadratic Formula 663

#### Mid-Chapter Review 669
- **9.4** Formulas 671
- **9.5** Applications and Problem Solving 677

#### Translating for Success 680
- **9.6** Graphs of Quadratic Equations 685

#### Visualizing for Success 689
- **9.7** Functions 693

#### Summary and Review 704
- **Test 709**
- **Cumulative Review 711**

### Appendices

- **A** Factoring Sums or Differences of Cubes 718
- **B** Finding Equations of Lines; Point-Slope Equation 722
- **C** Higher Roots 726
- **D** Sets 730
- **E** Mean, Median, and Mode 734
- **F** Inequalities and Interval Notation 737

#### Answers A-1
- **Guided Solutions A-31**
- **Glossary G-1**
- **Index I-1**
Sample preface. Not for distribution.
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2d</td>
<td>Order on the Number Line</td>
</tr>
<tr>
<td>2.7b</td>
<td>Graphing Inequalities</td>
</tr>
<tr>
<td>3.1d</td>
<td>Graphing Linear Equations</td>
</tr>
<tr>
<td>3.3a</td>
<td>Slope</td>
</tr>
<tr>
<td>3.3a</td>
<td>Slope of a Line</td>
</tr>
<tr>
<td>3.4a</td>
<td>Slope–Intercept Form</td>
</tr>
<tr>
<td>3.4a</td>
<td>Equations of Lines: Slope–Intercept Form</td>
</tr>
<tr>
<td>3.7b</td>
<td>Linear Inequalities in Two Variables</td>
</tr>
<tr>
<td>4.1f</td>
<td>Negative Exponents</td>
</tr>
<tr>
<td>4.6c</td>
<td>Special Products</td>
</tr>
<tr>
<td>5.7b</td>
<td>Intercepts and Solutions</td>
</tr>
<tr>
<td>6.8a</td>
<td>Motion Problems</td>
</tr>
<tr>
<td>7.4a</td>
<td>Mixture Problems</td>
</tr>
<tr>
<td>9.6a</td>
<td>Graphs of Quadratic Functions</td>
</tr>
<tr>
<td>9.6b</td>
<td>Intercepts and Solutions</td>
</tr>
<tr>
<td>9.7c</td>
<td>Graphing Functions</td>
</tr>
<tr>
<td>Appendix B</td>
<td>Equations of Lines: Point–Slope Form</td>
</tr>
</tbody>
</table>

Index of Animations
Photo Credits

JUST-IN-TIME REVIEW: 1, Ruslan Gusov/Shutterstock; dizanna/123RF CHAPTER 1: 27, CE Photography/Shutterstock; Wayne Lynch/Shutterstock 30, © SE Photography; Supriya Kadam, High Street/123RF 53, Edwara Silva/Santa Maria/Fotolia 36, Ed Metz/Shutterstock 43 (left), chuyu/123RF 43 (right), Carlos Villoch/MagicSea.com/Alamy Stock Photo 50, Comstock/Getty Images 56, Mellowbox/Fotolia 66, Ivan Alvarado/Alamy Stock Photos 69, Richard Whitcombe/123RF 105, Deposit Photos/Glow Images CHAPTER 2: 109, Angelo Cavalli/AFG Srl/Alamy; Design Pics Inc/Alamy 133, Leonid Tit/Fotolia 134, Artif Fongfung/123RF 137, SoCalBatGal/Fotolia 138 (left), Echel; Jochen/Sueddeutsche Zeitung Photo/Alamy 138 (right), Iakov Filimonov/Shutterstock 146, Luca Bertolfi/123RF 149 (left), ifofoto/Shutterstock 149 (right), John Kavouris/Alamy 150 (left), gasparij/123RF 150 (right), Anja Schaefer/Alamy 159, Stan Honda/Getty Images 160, Stephen VanHorn/Shutterstock 164 (top left), Rodney Todt/Alamy Stock Photo 164 (top right), Jasminko Ibrakovici/Shutterstock 164 (bottom left), courtesy of Indianapolis Motor Speedway 164 (bottom right), Lars Lindblad/Shutterstock 165 (left), Barbara Johnson 165 (right), Studio 8. Pearson Education Ltd. 181, RosalIreneBetancourt 3/Alamy Stock Photo 184, Andrei N Bannov/Shutterstock 187 (left), Reggie Lavoie/Shutterstock 187 (right), Monkey Business/Fotolia 191, perralgy/Fotolia 192, Don Mammoser/Shutterstock CHAPTER 3: 197, Africa Studio/Shutterstock; tethysimaginglle/123RF; zimmytw/Shutterstock 206, Andrej Popov/Shutterstock 230, David Pearson/Alamy 235 (left), marchcatllee/123RF 235 (right), Evan Meyer/Shutterstock 236 (left), Kostyantyn Pankin/123RF 236 (right), Wavebreak Media Ltd/123RF 268, arinahabich/Fotolia 276, Wei Ming/Shutterstock CHAPTER 4: 277, Trevor R A Dingle/Alamy Stock Photo; Universal Images Group North America LLC/DeAgostini/Alamy 279, NASA 290 (left), Universal Images Group North America LLC/DeAgostini/Alamy 290 (right), jezer/123RF 293, Lorraine Swanson/Fotolia 294, Darts/123RF 296 (left), luchsen/123RF 296 (right), Joanne Weston/123RF 297 (top), Engine Images/Fotolia 297 (bottom), NASA 298 (left), ScanPavonePhoto/Fotolia 298 (right), dreamerb/123RF 308 (left), Brian Buckland 308 (right), 341, Johan Swanepoel/123RF 345, Mark Harvey/Alamy CHAPTER 5: 367, Galina Peshkova/123RF; georgejmclittle/123RF; Rawpixel/Shutterstock 385, Zoonar/Chris Putnam/Age Fotostock 399, Free Spirit Spheres 430, georgejmclittle/123RF 435, Stephen Barnes/Alamy Stock Photo 443, Patti Steib/Shutterstock 448, Vlada Photo/Shutterstock CHAPTER 6: 449, MediaWorldImages/Alamy Stock Photo; modfios/123RF; Oleksandr Galata/123RF 468, Igor Normann/Shutterstock 503, Ingrid Balabanova/123RF 506, Ortodox/Shutterstock 511 (left), Elenathewise/Fotolia 511 (right), simon johnsen/Shutterstock 513 (left), Chris Dorney/123RF 513 (right), Rolf Nussbaumer/Photography/Alamy Stock Photo 514, Vicki Jaunor, Babylon and Beyond Photography/Getty Images 517, minadezhda/Fotolia 519, Foto Arena LTD/Alamy Stock Photo 521, EduardSV/Fotolia 523, iboo07/Shutterstock 529 (left), Dmitriy Kalinovsky/Shutterstock 529, James McConnachie © Rough Guides/Pearson Asset Library CHAPTER 7: 535, marina kuchenbecker/123RF; Balint Roxana/123RF 548, Kyodo News/AP Images 560, Steve Peeple/Shutterstock 561, RosalIreneBetancourt 13/Alamy Stock Photo 568 (top), Sandee House 568 (bottom), Natalia Klenova/123RF 586, moodboard/Corbis CHAPTER 8: 587, herjua/Shutterstock; awesleyfloyd/123RF 590, Koming Pinta/Shutterstock 593 (left), Akharrarat Wathanasing/123RF 593 (right), Agencia Fotografica Caro/Alamy 603, Fotokostie/Shutterstock 610, Alisa24/Shutterstock 628 (top), Andrey Yurlov/Shutterstock 628 (bottom), Akharrarat Wathanasing/123RF 631 (top), Photo courtesy LandWave Products, Inc., Pioneer OH 631 (bottom), Alan Ingram/Alamy Stock Photo CHAPTER 9: 645, perfectlab/Shutterstock; karen roach/123RF 659, Hayk Shalunts/Shutterstock 673, ESB Professional/Shutterstock 682, ronham/123RF 683, Vladimir Sazonov/Fotolia 699, rawpixel/123RF 714, Barbara Johnson APPENDIXES: 734, National Geographic Creative/Alamy Stock Photo 736 (left), Brent Hofacker/123RF 736 (right), Kvitka Fabian/Shutterstock
Math doesn’t change, but students’ needs and the way students learn – do.

With this in mind, *Introductory Algebra*, 13th Edition, continues the Bittinger tradition of objective-based, guided learning, while integrating many updates with the proven pedagogy. (These updates are motivated by feedback that we received from students and instructors, as well as our own experience in the classroom.) In this edition, our focus is on guided learning and retention: helping each student (and instructor) get the most out of all the available program resources—wherever and whenever they engage with the math.

We believe that student success in math hinges on four key areas: **Foundation**, **Engagement**, **Application**, and **Retention**. In the 13th Edition, we have added key new program features (highlighted below, for quick reference) in each area to make it easier for each student to personalize his or her learning experience. In addition, you will recognize many proven features and presentations from the previous edition of the program.

**FOUNDATION**

**Studying the Concepts**

Students can learn the math concepts by reading the textbook or the etext, participating in class, watching the videos, working in the *MyMathGuide* workbook—or using whatever combination of these course resources works best for them.

In order to understand new math concepts, students must recall and use skills and concepts previously studied. To support student learning, we have integrated two important new features throughout the 13th Edition program:

- **New!** *Just-in-Time Review* at the beginning of the text and the etext is a set of quick reviews of the key topics from previous courses that are prerequisites for the new material in this course. A note on each Chapter Opener alerts students to the topics they should review for that chapter. In MyLab Math, students will find a concise presentation of each topic in the *Just-in-Time Review Videos*.

- **New!** *Skill Review*, in nearly every section of the text and the etext, reviews a previously presented skill at the objective level where it is key to learning the new material. This feature offers students two practice exercises with answers. In MyLab Math, new *Skill Review Videos*, created by the Bittinger author team, offer a concise, stepped-out solution for each Skill Review exercise.

**Margin Exercises with Guided Solutions**, with fill-in blanks at key steps in the problem-solving process, appear in nearly every text section and can be assigned in MyLab Math.
Algebraic–Graphical Connections in the text draw explicit connections between the algebra and the corresponding graphical visualization.

Introductory Algebra Video Program, our comprehensive program of objective-based, interactive videos, can be used hand-in-hand with our MyMathGuide workbook. Interactive Your Turn exercises in the videos prompt students to solve problems and receive instant feedback. These videos can be accessed at the section, objective, and example levels.

MyMathGuide offers students a guided, hands-on learning experience. This objective-based workbook (available in print and in MyLab Math) includes vocabulary, skill, and concept review—as well as problem-solving practice with space for students to fill in the answers and stepped-out solutions to problems, to show (and keep) their work, and to write notes. Students can use MyMathGuide, while watching the videos, listening to the instructor’s lecture, or reading the text or the etext, in order to reinforce and self-assess their learning.

Studying for Success sections are checklists of study skills designed to ensure that students develop the skills they need to succeed in math, school, and life. They are available at the beginning of selected sections.

ENGAGEMENT
Making Connections through Active Exploration

Since understanding the big picture is key to student success, we offer many active learning opportunities for the practice, review, and reinforcement of important concepts and skills.

- **New! Chapter Opener Applications** with infographics use current data and applications to present the math in context. Each application is related to exercises in the text to help students model, visualize, learn, and retain the math.
- **New! Student Activities**, included in each chapter, have been developed as multistep, data-based activities for students to learn the math in the context of an authentic application. Student Activities are available in MyMathGuide and in MyLab Math.
- **New! Interactive Animations** can be manipulated by students in MyLab Math through guided and open-ended exploration to further solidify their understanding of important concepts.

Translating for Success offers extra practice with the important first step of the process for solving applied problems. Visualizing for Success asks students to match an equation or an inequality with its graph by focusing on characteristics of the equation or the inequality and the corresponding attributes of the graph. Both of these activities are available in the text and in MyLab Math.

Technology Connection is an optional feature in each chapter that helps students use a calculator to perform calculations and to visualize concepts.

Learning Catalytics uses students’ mobile devices for an engagement, assessment, and classroom intelligence system that gives instructors real-time feedback on student learning.

APPLICATION
Reinforcing Understanding

As students explore the math, they have frequent opportunities to apply new concepts, practice, self-assess, and reinforce their understanding.
Margin Exercises, labeled “Do Exercise . . .,” give students frequent opportunities to apply concepts just discussed by solving problems that parallel text examples. Exercise Sets in each section offer abundant opportunity for practice and review in the text and in MyLab Math. The margin exercises can be used for independent practice, and each set includes the following special exercise types:

- **New! Check Your Understanding** with Reading Check and Concept Check exercises, at the beginning of each exercise set, gives students the opportunity to assess their grasp of the skills and concepts before moving on to the objective-based section exercises. In MyLab Math, many of these exercises use drag & drop functionality.
- **Skill Maintenance Exercises** offer a thorough review of the math in the preceding sections of the text.
- **Synthesis Exercises** help students develop critical-thinking skills by requiring them to use what they know in combination with objectives from the current and previous sections.

RETENTION
Carrying Success Forward

Because continual practice and review is so important to retention, we have integrated both throughout the program in the text and in MyLab Math.

- **New! Skill Builder Adaptive Practice**, available in MyLab Math, offers each student a personalized learning experience. When a student struggles with the assigned homework, Skill Builder exercises offer just-in-time additional adaptive practice. The adaptive engine tracks student performance and delivers to each individual questions that are appropriate for his or her level of understanding. When the system has determined that the student has a high probability of successfully completing the assigned exercise, it suggests that the student return to the assigned homework.

Mid-Chapter Review offers an opportunity for active review midway through each chapter. This review offers four types of practice problems:

Concept Reinforcement, Guided Solutions, Mixed Review, and Understanding Through Discussion and Writing

Summary and Review is a comprehensive learning and review section at the end of each chapter. Each of the five sections—Vocabulary Reinforcement (fill-in-the-blank), Concept Reinforcement (true/false), Study Guide (examples with stepped-out solutions paired with similar practice problems), Review Exercises, and Understanding Through Discussion and Writing—includes references to the section in which the material was covered to facilitate review.

Chapter Test offers students the opportunity for comprehensive review and reinforcement prior to taking their instructor’s exam. Chapter Test-Prep Videos in MyLab Math show step-by-step solutions to the questions on the chapter test.

Cumulative Review follows each chapter beginning with Chapter 2. These revisit skills and concepts from all preceding chapters to help students retain previously presented material.

MyLab™ Math is available to accompany Pearson’s market-leading text offerings. To give students a consistent tone, voice, and teaching method, the pedagogical approach of the text is tightly integrated throughout the accompanying MyLab Math course, making learning the material as seamless as possible.

**UPDATED! Learning Path**

Structured, yet flexible, the updated learning path highlights author-created, faculty-vetted content—giving students what they need exactly when they need it. The learning path directs students to resources such as two new types of video: **Just-in-Time Review** (concise presentations of key topics from previous courses) and **Skills Review** (author-created exercises with stepped-out solutions that reinforce key prerequisite skills), both available in the Multimedia Library and assignable in MyLab Math.

**NEW! Drag-and-Drop Exercises**

Drag-and-drop exercises are now available in MyLab Math. This new assignment type allows students to drag answers and values within a problem, providing a new and engaging way to test students' concept knowledge.

**NEW and UPDATED! Animations**

New animations encourage students to learn key concepts through guided and open-ended exploration. Animations are available through the learning path and multimedia library, and they can be assigned within MyLab Math.

**Resources for Success**

[pearson.com/mylab/math](http://pearson.com/mylab/math)
Resources for Success

Instructor Resources
Additional resources can be downloaded from www.pearsonhighered.com or hardcopy resources can be ordered from your sales representative.

**Annotated Instructor's Edition**
ISBN: 0134718151
• Answers to all text exercises.
• Helpful teaching tips, including suggestions for incorporating Student Activities in the course

**Instructor’s Resource Manual with Tests and Minilectures**
(download only)
ISBN: 0134718313
• Resources designed to help both new and experienced instructors with course preparation and class management.
• Chapter teaching tips and support for media supplements.
• Multiple versions of multiple-choice and free-response chapter tests, as well as final exams.

**Instructor’s Solutions Manual**
(download only)
By Judy Penna
ISBN: 0134718240
The Instructor's Solutions Manual has detailed, worked-out solutions to all odd-numbered text exercises. In addition, brief solutions for even-numbered exercises available.

**PowerPoint® Lecture Slides**
(download only)
• Editable slides present key concepts and definitions from the text.
• Available to both instructors and students.
• Fully accessible.

**TestGen®**
TestGen enables instructors to build, edit, print, and administer tests using a computerized test bank of questions developed to cover all the objectives of the text. (www.pearsoned.com/testgen)

Student Resources
Additional resources to help student success.

**Introductory Algebra Lecture Videos**
• Concise, interactive, and objective-based videos.
• View a whole section, choose an objective, or go straight to an example.

**Chapter Test Prep Videos**
• Step-by-step solutions for every problem in the chapter tests.

**Just-in-Time Review Videos**
• One video per review topic in the Just-in-Time Review at the beginning of the text.
• View examples and worked-out solutions that parallel the concepts reviewed in each review topic.

**Skill Review Videos**
Students can review previously presented skills at the objective level before moving forward in the content. Videos are accompanied by two practice exercises with answers.

**MyMathGuide: Notes, Practice, and Video Path**
ISBN: 013471833X
• Guided, hands-on learning in a workbook format with space for students to show their work and record their notes and questions.
• Highlights key concepts, skills, and definitions; offers quick reviews of key vocabulary terms with practice problems, examples with guided solutions, similar Your Turn exercises, and practice exercises with readiness checks.
• Includes student activities utilizing real data.
• Available in MyLab Math and as a printed manual.

**Student’s Solutions Manual**
ISBN: 0134718178
By Judy Penna
• Includes completely worked-out annotated solutions for odd-numbered exercises in the text, as well as all the exercises in the Mid-Chapter Reviews, the Summary and Reviews, the Chapter Tests, and the Cumulative Reviews.
• Available in MyLab Math and as a printed manual.

 Pearson.com/mylab/math
Acknowledgments

Our deepest appreciation to all the instructors and students who helped to shape this edition through their efforts by reviewing our texts and courses, providing feedback, and sharing their experiences with us at conferences and on campus. In particular, we would like to thank the following for reviewing the titles in our Worktext program for this revision:

Alexandria S. Anderson, Columbia Basin University;
Amanda L. Blaker, Gallatin College;
Jessica Bosworth, Nassau Community College;
Judy G. Burns, Trident Technical College;
Abushieba A. Ibrahim, Nova Southeastern University;
Laura P. Kyser, Savannah Technical College; and
David Mandelbaum, Nova Southeastern University.

An outstanding team of professionals was involved in the production of this text. We want to thank Judy Penna for creating the new Skill Review videos and for writing the Student's Solutions Manual and the Instructor's Solutions Manual. We also thank Laurie Hurley for preparing the Instructor's Resource Manual, Robin Rufatto for creating the new Just-in-Time videos, and Tom Atwater for supporting and overseeing the new videos. Accuracy checkers Judy Penna, Laurie Hurley, and Susan Meshullam contributed immeasurably to the quality of the text.

Martha Morong, of Quadrata, Inc., provided editorial and production services of the highest quality, and Geri Davis, of The Davis Group, performed superb work as designer, art editor, and photo researcher. Their countless hours of work and consistent dedication have led to products of which we are immensely proud.

In addition, a number of people at Pearson, including the Developmental Math Team, have contributed in special ways to the development and production of our program. Special thanks are due to Cathy Cantin, Courseware Portfolio Manager, for her visionary leadership and development support. In addition, Ron Hampton, Content Producer, contributed invaluable coordination for all aspects of the project. We also thank Erin Carriero, Media Producer, and Kyle DiGiannantonio, Marketing Manager, for their exceptional support.

Our goal in writing this textbook was to make mathematics accessible to every student. We want you to be successful in this course and in the mathematics courses you take in the future. Realizing that your time is both valuable and limited, and that you learn in a uniquely individual way, we employ a variety of pedagogical and visual approaches to help you learn in the best and most efficient way possible. We wish you a positive and successful learning experience.

Mary Bittinger
Judy Beecher
Barbara Johnson