

# Fundamentals of Mathematics

8th Edition



WILLIAM M. SETEK, JR • MICHAEL A. GALLO

# Fundamentals of Mathematics

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Eighth Edition

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# **Fundamentals of Mathematics**

***To my wife, Addie, for her encouragement, understanding,  
assistance, and patience throughout this project,  
and to my sons, Scott and Joe, who helped in their  
own special way.***

**W. M. S.**

***To Janie ... my wife and cutie π***

**M. A. G.**



# To the Instructor

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In writing this eighth edition of *Fundamentals of Mathematics*, we have tried to reflect the changing approach to teaching liberal arts mathematics courses. The student population of colleges has changed significantly; there is a greater diversity of students enrolled in the typical liberal arts mathematics course. Today, such a course may enroll students ranging from recent high school graduates to mature students with a wide variety of mathematical backgrounds. Ability, interest, and motivation vary greatly among these students, and many of them suffer from “math anxiety.” As a result, the course content has become more diversified.

The only prerequisites for this text are a desire to learn and a working knowledge of arithmetic. Typically, the prerequisite for colleges offering this course is one unit of high school mathematics. The approach is intuitive. This text contains an abundance of completely worked-out examples with systematic step-by-step solutions; there are no gaps or “magic” solutions. We have found that this type of experience provides the student with confidence and competence when doing homework or exam problems. Previous editions of this text have been described as “user friendly” by students.

## IN THE EIGHTH EDITION

The elements of the previous editions that proved successful remain in this edition. Nevertheless, many changes, some obvious, others subtle, have been made. Virtually every change is the result of thoughtful comments and suggestions from colleagues and students who have used previous editions. As a result of that input, for which we are sincerely grateful, this edition is an improved teaching device for professors and a better learning tool for students.

### Key Content Changes

**Chapter 1, Fundamentals of Problem Solving**, includes an introduction of recursion and concept of recurrence relations; Fibonacci sequence as an example of a recurrence relation, the concept of finite and infinite sequences; and modifications throughout the chapter to make it more mathematically sound.

**Chapter 2, Sets**, now introduces the concept of Euler circles.

**Chapter 3, Logic**, provides an alternative method for constructing truth tables, using tree diagrams to help decompose a complex statement into simple statements. The original method for constructing truth tables is maintained, thus providing instructors and students with an option regarding which method to use. An alternative method is also provided for determining the validity of an argument - using Euler circles. Again, the original method is maintained, thus offering instructors and students an option regarding which method to use.

**Chapter 4, Probability**, now features expanded explanations and some revised exercises.

**Chapter 5, Statistics**, introduces stem-and-leaf displays, and a new section on uses and misuses of statistics.

**Chapter 9, An Introduction to Algebra**, features an expanded introduction to the chapter, enhancing student understanding of what lies ahead; includes new vocabulary terms (such as factor, coefficient, combining like terms); offers new exercises that include evaluating algebraic expressions and formulas; and provides modified exercise sets throughout the chapter.

**Chapter 10, Selected Topics in Algebra**, offers modified exercise sets throughout the chapter.

**Chapter 12, Consumer Mathematics**, includes expanded coverage, completely updated for the eighth edition.

## Pedagogical Enhancements



**New! WWW Applications.** Written by Hester Lewellen, this new feature provides students with exercises designed to help them explore and utilize the world wide web. Included in each chapter, these special exercises are denoted by a unique icon for easy identification. The icon prompts students to go to the PH Companion Website, and check out the Internet applications written specifically to reinforce chapter content. Team Work projects are also housed on the PH Companion Website for easy accessibility by students/teams. For a closer look at this new feature, see the *Text Walk-Through* on pages xx–xxiii.

**Historical Notes and Notes of Interest.** Both of these features are designed to enhance student learning by providing additional tidbits of noteworthy information. These relevant sidebars have been updated and expanded as appropriate for the eighth edition.

**Team Work projects.** In each chapter, a full page is devoted to collaborative learning. These “Team Work” exercises were written by Hester Lewellen, one of the co-authors of the University of Chicago High School Mathematics Project, and have been updated as appropriate for the eighth edition. These multi-tasked projects will get your students together and have them problem solve in a cooperative manner. All of the projects require critical thinking and communication.

**Illustrations.** Many new illustrations have been included to provide a dynamic realism to selected examples and exercises. All line art has been computer generated for consistency and accuracy. Containing well over eight hundred illustrations and photos, our goal is to help students visualize mathematics and use that visualization in solving mathematical problems.

**Examples.** In addition to the solid traditional examples used in earlier editions, we added many new fully worked out examples (now totaling over six hundred) into the text.

**Exercises.** Roughly 25% of the exercises have been updated and revised since the last edition. To further encourage students to become active participants, each exercise set concludes with a “Just for Fun” problem. These problems range from serious extensions of mathematical ideas in the text to light-hearted puzzles and “brain teasers.” They have been chosen primarily to capture student interest. Users of previous editions have been pleased with the results.

Answers to the exercises appear in the back of the text for all the odd-numbered problems. Fully worked out solutions for the odd-numbered problems are found in the Student Study Guide and Solutions Manual, and the even answers are located in the Instructor's Resource and Solutions Manual. For a closer look at the text's many features, turn to the *Text Walk-Through* on pages xx–xxiii.

## INSTRUCTOR SUPPLEMENTS

**Instructor's Resource and Solutions Manual.** Contains complete step-by-step worked out solutions to all exercises in the textbook. Also included are strategies for using the collaborative learning projects found in each chapter, teaching suggestions, and sets of more challenging exercises.

**ABC Videos.** Containing news “clips” from current ABC News shows, these videos are a collection of mathematically relevant and interesting topics. These video clips are perfect for increasing interest and understanding the role of mathematics in the world around us.

**Test Item File.** With over 1000 questions, this test bank allows easy creation of full tests and quizzes for your students.

**Prentice Hall Custom Test (computerized testing generator—Mac and IBM).** This easy to use test generator contains all the questions from the written test item file. Two types of test creations are possible: the *Easycost* for the novice computer user and *Fulltest* for those who wish to write their own questions or create their own graphics.

## STUDENT SUPPLEMENTS

**Student Study Guide and Solutions Manual.** This combined Study Guide and Solutions Manual contains step-by-step worked out solutions to all the odd-numbered exercises in the textbook and a comprehensive study guide. This is helpful for your students to obtain instant feedback while studying.

## INSTRUCTOR AND STUDENT SUPPLEMENT

### PH Companion Website

Designed to complement and expand upon the text, the PH Companion Website includes the new *WWW Applications*, *Solutions to the WWW Applications*, and *Team Work projects* found in the eighth edition. It also offers a variety of interactive teaching and learning tools including: links to related websites, practice work for students, and the ability for instructors to monitor and evaluate students' work on the website. For more information, contact your local Prentice Hall representative.

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For more information on any of the supplements, please contact your Prentice Hall representative.

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W.M.S.  
M.A.G.

# To the Student

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This book is designed to help you learn some mathematics, regardless of your mathematical background. It is written so that you can understand, appreciate, and even enjoy areas of mathematics to which you may or may not have been exposed. But, in order for this to occur, you must use this book. Someone once said:

*I hear and I forget.*

*I see and I remember.*

*I do and I understand.*

Mathematics is not a spectator subject; it is a participation sport—you must actively use the text. Here are some hints we give our students at the beginning of the course:

1. Read the text with pencil in hand—*before the lecture*. Knowing what to expect and what is in the book, you can take fewer notes and spend more time listening and understanding the lecture.
2. Work the illustrative examples. There are more examples in this text than in any other of this nature. Their purpose is to help you understand the material and learn by doing. Make use of the wide margins—they are designed for “scratch” work.
3. If you are confused about something, visit your instructor during office hours immediately, before you fall behind. Bring your attempted solutions to problems with you to show your instructor where you are having trouble.
4. To study for the exam, begin by reviewing each chapter and your notes, then concentrate on the end-of-chapter problems.

We encourage you to look through the following *Text Walk-Through* and become familiar with the different learning aids that will appear and how they can be used to understand the material.

And we hope you will find reading and using this book a worthwhile and enjoyable endeavor. Good luck! We welcome any and all comments. Feel free to write and let us know your thoughts and reactions to this text.

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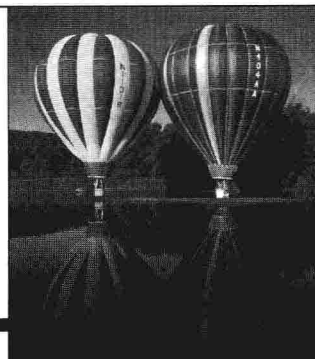
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# Fundamentals of Mathematics, Eighth Edition offers a number of pedagogical features.... Take a look for yourself!

Designed for your success, each chapter opens with a list of **learning objectives**, a **chapter outline**, and **frequently used symbols** to prepare you for the chapter material ahead.

## chapter 2

### Sets



#### ▶ AFTER STUDYING THIS CHAPTER, YOU WILL BE ABLE TO DO THE FOLLOWING:

1. Describe the meaning of the word **set**, and write a given set in two ways.
2. Identify **well-defined sets**, **finite sets**, and **infinite sets**.
3. Identify **equal sets**, **equivalent sets**, and **disjoint sets**.
4. Find the **subsets** and **proper subsets** of a given set.
5. Identify a **universal set** and find the **complement** of any set contained in some universal set.
6. Find the **intersection** and **union** of two or more sets.
7. Draw **Venn diagrams** to show the relationship between sets.
8. Show a **one-to-one correspondence** between any two equivalent sets and find the **cardinality** of sets.
9. Use Venn diagrams to solve survey problems.
10. Determine the **Cartesian product** ( $A \times B$ ) of two sets  $A$  and  $B$ .

Note: \* indicates optional material.

#### ▶ CHAPTER OUTLINE

- |                              |                                              |
|------------------------------|----------------------------------------------|
| 2.1 Introduction             | 2.5 Pictures of Sets (Venn Diagrams)         |
| 2.2 Notation and Description | 2.6 An Application of Sets and Venn Diagrams |
| 2.3 Subsets                  | 2.7 Cartesian Products                       |
| 2.4 Set Operations           |                                              |

#### ▶ SYMBOLS FREQUENTLY USED IN THIS CHAPTER

$\{ \}$	braces, used to enclose members of a set
$\in$	"is an element of"
$\notin$	"is not an element of"
$\dots$	proceed in the indicated pattern
$\emptyset$	the empty set, also denoted by $\{ \}$
$\subset$	"is a proper subset of"
$\subseteq$	"is a subset of"
$\not\subseteq$	"is not a subset of"
$U$	the universal set
$A'$	the complement of $A$
$\cap$	intersection
$\cup$	union
$n(A)$	the cardinal number of set $A$
$(a, b)$	the ordered pair $a$ and $b$
$=$	"is equal to"
$A \times B$	the Cartesian product of sets $A$ and $B$
$a/b$	$a$ such that $b$
$n!$	$n$ factorial
	$n! = n \times (n - 1) \times \cdots \times 3 \times 2 \times 1$

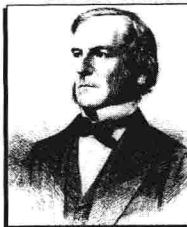


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## HISTORICAL NOTE



It was not until the early twentieth century that logic came to be considered part of the study of mathematics.

George Boole (1815–1864), an English mathematician, was primarily responsible for this acceptance. His book *Laws of Thought* developed logic as an abstract mathematical system. It consisted of undefined terms, binary operations, and rules for using these operations on the terms. Today, we know the terms as propositions; the operations are the conjunction, disjunction, and negation.

Boole was able to use logic as a special kind of algebra. The system follows many of the rules of ordinary arithmetic. Today Boolean algebra is used extensively in the design of computers.

The advantage of Boole's symbolic notation is that many errors in reasoning are greatly reduced. The ambiguities of language are avoided by the use of symbols because once a problem is translated into symbolic notation, the solution becomes mostly mechanical.

### 3.2 STATEMENTS AND SYMBOLS

In preparing for any task, we must first equip ourselves with the proper tools and the “know-how” required to do the job. The first thing that we must be able to do is identify and symbolize sentences. In logic we concern ourselves only with those sentences that are either true or false, but not both. A **statement** is a declarative sentence that is either true or false (but not both true and false).\* We shall not concern ourselves with sentences that cannot be assigned a true or false value. (Sentences of this nature are usually questions or commands.)

Note that it is not possible to assign a true or false value to the following:

Did you do the assignment?


*Hand in your paper.*

**Key Terms** appear in boldface where they are defined. This makes reviewing for exams easier.

An eye-catching **calculator icon** helps you identify when using a calculator is the most appropriate way to solve a problem.

No “Magical Missing Steps” in these examples...

Each step is clearly marked and explained.

Note: The symbol  indicates problems more readily done with a calculator.

**EXAMPLE 1:** What is the effective rate, if money is invested at 8% compounded quarterly?

**Solution** The number of payment periods is four, because interest is compounded quarterly. The interest rate per period is  $8\% \div 4 = 2\%$ . Therefore,  $r = 0.02$ . Substituting these values in the formula, we have

$$\begin{aligned} \text{Calculator icon} \quad E &= (1 + r)^n - 1 \\ E &= (1 + 0.02)^4 - 1 \\ E &= (1.02)^4 - 1 \\ E &= 1.0824 - 1 \\ E &= 0.0824, \text{ or } 8.2\% \text{ (to the nearest tenth)} \end{aligned}$$

This answer checks with the one we obtained earlier in this section using the compound-interest table. ▲

In Example 1 we rounded our answer to the nearest tenth so that it could be compared with the first illustrative example in this section. However, all other problems in this section will be rounded to the nearest hundredth of a percent. Also, it is recommended that any calculation involving the use of this formula be done on a calculator.

**EXAMPLE 2:** What is the effective rate, if money is invested at 7% compounded semiannually?

**Solution** We substitute  $n = 2$  and  $r = 7\% \div 2 = 3.5\% = 0.035$  into the formula:



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## 1.6

## PROBLEM-SOLVING STRATEGIES

Thus far we have studied several techniques of problem solving. Some of the strategies included asking questions to better understand a problem, identifying common patterns or themes, using inductive reasoning, recalling past experiences or solutions, looking at a problem from different perspectives, breaking down a problem into smaller parts (top-down processing). In this section we consolidate that information into a coherent, logical framework that can be used as a general guide for solving problems.

In his book *How to Solve It*, George Polya lists four main phases, or steps, to problem solving, as outlined below.

**Notes of Interest** are intriguing tidbits of information you might not know about the world of mathematics.

### ▼ Not of Interest

1 1  
1 2 1  
1 3 3 1  
1 4 6 4 1  
1 5 10 10 5 1

This array of numbers is known as “Pascal’s triangle.” We can construct such an array by the following method. In each row, the first and last numbers are always 1. Any number in the array is the sum of the two numbers it lies between on the line above. Five rows are shown (it may be extended).

The sum of the numbers in any row yields the total number of combinations possible within that group. For example, to find the probability of any boy–girl combination in a family of four children, we examine the fourth row. Note that the sum of the numbers is 16, the number of different outcomes. The numbers at the ends of the row represent the chances of the least likely events—that is, all boys or all girls: 1 in 16. The next number from end represents the next type of combination, three boys and one girl or vice versa: 4 in 16. Finally, the chances of having two boys and two girls are 6 in 16.

Pascal did not invent the triangle that bears his name; some Chinese works of the early 1300s contain such an array of numbers. (See p. 308) However, because he discovered and applied many of its properties, this triangular array has become known as Pascal’s

In the “real world,” coworkers often collaborate to solve more difficult problems—or problems that may have more than one answer. Each chapter includes a **“Team Work”** project for you and your classmates to work on together.

The new **WWW Applications** are designed to help you explore and utilize the World Wide Web. The easy-to-identify icon prompts you to check out these applications located on the Prentice Hall companion website at [www.prenhall.com/setek](http://www.prenhall.com/setek)

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## T E A M W O R K

### Who Gets the Prize?

**T**hree car dealerships in Milwaukee were vying for a bonus from General Motors. The prize would go to the dealership that had the best record of new car sales for the month of November. At the end of the month each dealership claimed to have had the best record: each one said they should get the bonus.

When the accountants at GM called up the records on their computers, this is what they saw. (For purposes of simplification, we will show only one *typical* sales day in which each dealer sold 5 cars. Figures are rounded to thousands.)



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**Just for Fun** problems extend your mathematical thinking through the use of light-hearted puzzles and “brain teasers.”



## JUST FOR FUN

If you are given 10 pennies and three coffee cups, can you place all of the pennies in the three coffee cups so that there is an odd number of coins in each coffee cup? Each cup has to contain at least one penny.

## CHAPTER REVIEW MATERIALS

## Summary

A *sample space* is the set of all possible outcomes to a given experiment. An *event* is any subset of a sample space. If an experiment has a total of  $T$  *equally likely* outcomes, and if exactly  $S$  of these outcomes are considered successful—that is, they are the members of the event  $A$ —then the probability that event  $A$  will occur is

$$P(A) = \frac{\text{Number of successful outcomes}}{\text{Total number of all possible outcomes}} \\ = \frac{S}{T}$$

When two or more experiments are performed together, the *counting principle* can sometimes be used to determine the total number of possible outcomes in the sample space. If one experiment has  $m$  different outcomes, and a second experiment has  $n$  different outcomes, then the first

the probability of two or more events occurring together, we multiply the various probabilities together. That is,

$$P(A \text{ and } B) = P(A) \times P(B)$$

We must assume that event  $A$  has occurred before calculating the probability of event  $B$  (even when “assuming that event  $A$  has occurred” has not been stated).

When we have mutually exclusive events and we want to compute the probability of  $A$  or  $B$ , we have

$$P(A \text{ or } B) = P(A) + P(B)$$

At the end of each chapter, the **Summary**, **Vocabulary Check**, and **Review Exercises** help you determine your level of understanding of the materials in the chapter. Do a final check using the **Chapter Quiz**.

## Vocabulary Check

\* combinations  
dependent events  
equally likely events  
expectation

\* factorial  
fundamental counting  
principle  
independent events

mutually exclusive  
events  
odds  
\* permutations

probability  
sample space  
tree diagram

Note: \* indicates optional material.

## Review Exercises

- On a single draw from a bag containing four red, six blue, and three green balls, find the probability of obtaining
  - a red ball
  - a blue ball
  - a red or a green ball
  - a ball that is not red

- Five thousand tickets are sold for a drawing on a boat valued at \$100,000. If a woman buys one ticket, what is her mathematical expectation?
- A fraternity sold 500 raffle tickets at \$2 each on a color television set valued at \$400. If Joe Kool buys five tickets, what is his mathematical expectation?
- A bag contains five balls numbered 1 through 5. Two balls are chosen in succession. The first ball is replaced before the second is drawn. Are these events *dependent* or *independent*? Why?
- The object of a game is to obtain a 7 or 11 with a single toss of a pair of dice. Are these events *mutually exclusive*? Why?
- The New York State Lottery Commission runs a daily lottery where a player chooses a three-digit number (any three digits from 000 through 999). A lottery ticket costs \$1 and if a player chooses the winning number, the payoff (prize) is \$500.

## Chapter Quiz

Determine whether each statement (1–20) is true or false.

- Each of the measures of central tendency—mean, median, mode, and midrange—is an “average.”
- The *median* for a set of data is found by arranging the data in sequential order and finding the middle value.
- A given set of data may have more than one *mode*.
- The *range* for a set of data is also a measure of central tendency.
- The *midrange* is a measure of dispersion.
- If Angie is first in her class, then she is at the 100th percentile.
- The mean of the squared deviations will always be a nonnegative value.
- When a student is told that he scored at the 77th percentile on an exam, he then knows that he received a score of 77% on the exam.
- The position of a piece of data, in terms of standard deviations from the mean, is called the *Z-score*.
- The first quartile for a set of data is the value that has 75% of the data below it.
- If Sam scored at the zero percentile, then he scored the highest in his class.
- Grouped frequency distributions representing the same set of data may be different.
- The tails of a normal curve must touch the horizontal axis.
- Circle graphs are used in showing how a whole quantity is divided into parts.
- A histogram consists of a series of bars that are drawn all with the same widths on the vertical axis, and uniform units on the horizontal axis.
- A frequency polygon is a type of histogram.
- A normal bell-shaped distribution will have a range that is approximately equal to six standard deviations.
- For normally distributed data, approximately 68% of the data will be included within an interval of one standard deviation about the mean.
- If we have data that are approximately normally distributed, then the mean, median, and mode all have approximately the same value.
- All normal curves appear the same.
- Given the set of data {70, 70, 70, 65, 60}, find the standard deviation.
- In a class of 30 students, Mike has a percentile rank of 70. What is his numerical rank?
- In a class of 40 students Irene has a rank of 10th. What is her percentile rank?
- Given the set of data {30, 35, 36, 37, 38, 39, 40, 41}, what score is at the first quartile?
- Sandra is ranked 50th in her senior class of 200 students. Eileen is in the same senior class and Eileen has a percentile rank of 72. Who has the higher standing in the class?

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