



# **FUNDAMENTALS OF MATHEMATICS**

**Sixth Edition**

**WILLIAM M. SETEK, JR.**

---

# Fundamentals of Mathematics

SIXTH EDITION

---

William M. Setek, Jr.

*Monroe Community College*

MACMILLAN PUBLISHING COMPANY

NEW YORK

Editor: Robert Pirtle  
Production Supervisor: Susan L. Reiland  
Production Manager: Aliza Greenblatt  
Text Designer: Andrew P. Zutis  
Cover Designer: Blake Logan  
Cover Photograph: Copyright 1991, Comstock  
Photo Researcher: Diane Kraut  
Illustrations: Vantage Art; Carl Brown

This book was set in Times Roman by Polyglot Compositors, and printed and bound by R. R. Donnelley & Sons. The cover was printed by Lehigh Press.

Copyright © 1992 by Macmillan Publishing Company,  
a division of Macmillan, Inc.

Printed in the United States of America

All rights reserved. No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the Publisher.

Earlier editions, copyright © 1989 and 1986 by Macmillan Publishing Company, copyright © 1983, 1979, and 1976 by William M. Setek, Jr.

Macmillan Publishing Company  
866 Third Avenue, New York, New York 10022

Macmillan Publishing Company is part of the  
Maxwell Communication Group of Companies

Maxwell Macmillan Canada, Inc.  
1200 Eglinton Avenue East  
Suite 200  
Don Mills, Ontario M3C 3N1

Library of Congress Cataloging-in-Publication Data  
Setek, William M.

Fundamentals of mathematics / William M. Setek, Jr.—6th ed.  
p. cm.

Includes index.

ISBN 0-02-409270-3

1. Mathematics. I. Title.

QA39.2.S48 1992

510—dc20

91-18757  
CIP

Printing: 3 4 5 6 7 Year: 2 3 4 5 6 7 8

Photo credits: frontispiece, Michael Tcherevkoff, The Image Bank; Chapter 1, Tom Sanders, The Stock Market; Chapter 2, © Steven Baratz 1986, The Picture Cube; Chapter 3, Juan Venegez, SIPA Press; Chapter 4, © Laima Druskis, Photo Researchers, Inc.; Chapter 5, © Mark Antman, The Image Works; Chapter 6, Photo Researchers, Inc.; Chapter 7, Michael Kagan, Monkmeyer Press Photo Service; Chapter 8, © Jim Kalett, Photo Researchers, Inc.; Chapter 9, Hugh Rogers, Monkmeyer Press Photo Service; Chapter 10, Owen Franken, Stock Boston; Chapter 11, © Teri Leigh Stratford, Photo Researchers, Inc.; Chapter 12, Roger Dollarhide, Monkmeyer Press Photo Service.

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

# Preface

In writing this sixth edition of *Fundamentals of Mathematics*, I have tried to reflect the changing approach to teaching liberal arts mathematics courses. The student population of colleges has changed; 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. Motivation and interest vary greatly among these students, and many of them suffer from “math anxiety.” Consequently, the course content has become more diversified.

The only prerequisite for this text is a working knowledge of arithmetic. The approach is intuitive. The text contains an abundance of completely worked-out examples with systematic step-by-step solutions; there are no gaps or “magic” solutions. I have found that this type of experience provides the student with confidence and competence when doing homework or test problems.

## ORGANIZATION OF THE TEXT

The text is divided into twelve chapters. Chapters 1 and 2 develop the basic ideas of sets and logic from an intuitive standpoint. Generous use is made of Venn diagrams and truth tables. Chapters 3 and 4 introduce the student to probability and statistics. Chapter 5 gives a thorough treatment of the metric system, emphasizing both metric–metric and metric–English conversions. Chapters 6, 7, and 8 are designed to broaden students’ ideas about mathematics by exposing them to various mathematical systems and systems of numeration and the structure of the real number system. Chapter 9 gives the student an introduction to algebra, including experience in solving elementary linear equations, graphing equations and inequalities, solving word problems, and

solving quadratic equations by means of the quadratic formula. Also new to this edition are complete sections on determining the slope of a line and writing the equation of a line. Chapter 10 provides an introduction to many different topics in geometry including perimeter, area, volume, and surface area. Chapter 11 covers a number of mathematical topics of use to students in their role as consumers. Chapter 12 introduces the student to the computer, including practice in writing programs using the BASIC language.

#### FEATURES OF THE SIXTH EDITION

The sixth edition of *Fundamentals of Mathematics* reflects many improvements suggested by instructors and students who used the fifth edition. Expanded explanations, additional exercises, and updated exercises have been added to Chapter 1 (Sets) and Chapter 3 (Probability). Chapter 4 (Statistics) has been updated throughout and contains an expanded section on graphs. Chapter 6 (Mathematical Systems) has been expanded with additional examples and exercises. Chapter 9 (An Introduction to Algebra) contains two new optional sections: The Slope of a Line and The Equation of a Straight Line. Changes and additions have also been made to Chapter 11 (Consumer Mathematics) and Chapter 12 (An Introduction to Computers). Additional Notes of Interest and Historical Notes have been added to Chapters 1, 3, 6, 7, 8, 11, and 12.

As with the fifth edition, the emphasis in this text is on encouraging the student to participate actively—to do mathematics by working examples and problems, as described in *To the Student*. To this end, the more than 600 worked-out examples in this text have been thoroughly reviewed for clarity and effectiveness, the many exercises have been reevaluated, and new examples and exercises have been added. The chapter review exercises are carefully designed to test the learning objectives given at the beginning of each chapter, and the 25 questions in each Chapter Quiz further test the learning objectives. The lists of selected words serve as a vocabulary check for each chapter, and a glossary of all these terms is found at the back of the book.

Typically the review exercises and chapter quizzes should be done in preparation for the unit or chapter exams. These have been found to serve as excellent preparation for the examinations.

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 for their ability to capture student interest, and users of previous editions have been pleased with the results.

Student interest also is enhanced by Historical Notes and Notes of Interest in every chapter.

**COURSE OUTLINES** Since liberal arts mathematics is not a well-defined course and its content varies from one school to the next, several suggested course outlines follow. Essentially, the chapters of this text are designed to be independent of one another so that the topics can be covered in any order. A student who fails to master the material in one chapter will not necessarily be at a disadvantage when a new topic is begun. Many users of earlier editions began their course with Chapter 1 (Sets), others began with Chapter 3 or 4 (Probability or Statistics), and still others began with other chapters that suited the needs of their classes.

**Suggested Course Outlines**

Chapters	Possible Omissions	Time Allotment
1–6, 12	Secs. 2.8–2.11, 3.7–3.9	one semester
2–6, 11, 12	Secs. 2.8–2.11, 3.7–3.9	one semester
3–6, 9–12	Secs. 3.7–3.9, 9.8, 9.9, 9.11	one semester
1, 2, 5–8, 12	Secs. 2.8–2.11, 8.7, 8.8	one semester
1, 2, 4, 9–12	none	one semester
1–12	Chapters 1, 6, 10	two semesters

**PEDAGOGICAL AIDS** Each chapter begins with learning objectives and a list of the symbols that will be introduced in the chapter. A generous set of exercises, graded in level of difficulty, follows each section. In addition, each chapter concludes with a summary, a vocabulary check, a set of review exercises, and a chapter quiz. The review exercises are organized so that they test each learning objective in order; more challenging exercises that require the student to master several objectives are placed at the end of the review exercise set. Almost all exercises may be done with pencil and paper, but some are more readily done with a calculator. We have marked these problems with the symbol □. Starred (★) exercises are considered optional as they are more challenging.

The answers to all odd-numbered exercises (including their multiple parts) are given for each section, along with all answers to the chapter review exercises and chapter quizzes. Therefore, assignments can be made with confidence in either fashion—with or without answers available.

**SUPPLEMENTARY MATERIALS** A number of supplementary aids are available. Three of the most significant are a comprehensive *Student Study Guide*, a *computer*



*disk* that may assist students or instructors by generating additional drill or test exercises, and a *complete solutions manual*.

The Study Guide has been developed to be used in conjunction with this text. Each section of the Study Guide directly corresponds to each section of the textbook. The material contained in the Study Guide represents a streamlined version of the material from the textbook. Each section has been carefully written so that it can provide added depth and insight to important topics and concepts. All examples presented in the Study Guide correspond to selected odd-numbered problems from the textbook. The Study Guide also assumes the role of a solutions manual. In addition, the appendix of the Study Guide contains a list of notation and symbols used in the text, tables of information, a summary of important geometric facts and formulas, various topics that are not formally addressed in the textbook, and useful information regarding the College Level Academic Skills Test (CLAST).

The computer disk has been prepared using the learning objectives at the beginning of each chapter. It can be used by the instructor to produce examinations with a multitude of test questions that are different but equal. It can also be used to produce multiple questions for a specific objective, thus serving as a learning tool for the student.

The solutions manual provides complete worked-out solutions to all exercises in the text. It can be a valuable resource for students and instructors.

The Instructor's Manual contains answers to the even-numbered exercises for each section, teaching suggestions, sets of more challenging exercises for each chapter, suggested projects and student activities, and a list of films and readings related to the topics in the text. A test package containing three examinations for each chapter is also contained in the Instructor's Manual.

## ACKNOWLEDGMENTS

I am grateful and indebted to those users of the fifth edition who provided me with many valuable suggestions and constructive criticisms—in particular my students and colleagues at Monroe Community College—and those who reviewed the manuscript for this edition: Barbara Brook, Camden County College; John Longnecker, University of Northern Iowa; and Amitabha Tripathi, Fairmont State College.

I would like to thank those at Macmillan Publishing Company, particularly Bob Pirtle, for their enthusiastic interest and support throughout the project.



A special note of appreciation goes to my wife, Addie, and to my sons, Scott and Joe.

To Pam Dretto, thank you for continued excellent work. Special thanks to David Rogachefsky for his support and assistance. A special tribute and thank you to Florence Whittaker who helped in a variety of ways. This edition would not have been possible without her attention to detail and perseverance.

W. M. S.

# To The Student

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. Read it with pencil in hand. Work the illustrative examples. There are more examples in this text than 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.

The Objectives, Chapter Summaries, Chapter Review Exercises, Chapter Quizzes, and Vocabulary Checks are designed to highlight the contents of each chapter, and to help you check your progress. [Starred (\*) exercises are considered optional as they are more challenging. Exercises marked □ are more readily done with a calculator.] The Historical Notes and Notes of Interest are designed to provide you with some insight into the development of mathematics. Finally, the Just for Fun problems are just that. They are provided as a change of pace. Some are relevant, some are not.

A Student Study Guide is also available. It contains additional problems, explanations, and worked-out solutions.

I hope you will find reading and using this book a worthwhile and enjoyable endeavor. Good luck!

I welcome any and all comments. Feel free to write and let me know your thoughts and reactions to this text.

William M. Setek, Jr.  
Monroe Community College  
Rochester, New York 14623

# Contents

## To the Student

xiii

### 1

#### Sets 1

1.1	Introduction	2
1.2	Notation and Description	2
1.3	Subsets	8
1.4	Set Operations	13
1.5	Pictures of Sets (Venn Diagrams)	17
1.6	An Application of Sets and Venn Diagrams	31
1.7	Cartesian Products	38
	Summary	42
	Vocabulary Check	42
	Review Exercises for Chapter 1	43
	Chapter Quiz	44

### 2

#### Logic 46

2.1	Introduction	48
2.2	Statements and Symbols	48
2.3	Dominance of Connectives	59
2.4	Truth Tables	64
2.5	More Truth Tables—Conditional and Biconditional Statements	68
2.6	De Morgan's Law and Equivalent Statements	76
2.7	The Conditional (Optional)	80
2.8	Valid Arguments	89

	2.9	Picturing Statements with Venn Diagrams (Optional)	96
	2.10	Valid Arguments and Venn Diagrams (Optional)	103
	2.11	Switching Networks (Optional)	109
		Summary	118
		Vocabulary Check	119
		Review Exercises for Chapter 2	119
		Chapter Quiz	121
<b>3</b>			
<b>Probability</b>			<b>124</b>
	3.1	Introduction	126
	3.2	Definition of Probability	126
	3.3	Sample Spaces	132
	3.4	Tree Diagrams	140
	3.5	Odds and Expectation	144
	3.6	Compound Probability	153
	3.7	Counting, Ordered Arrangements, and Permutations (Optional)	161
	3.8	Combinations (Optional)	172
	3.9	More Probability (Optional)	177
		Summary	182
		Vocabulary Check	183
		Review Exercises for Chapter 3	184
		Chapter Quiz	186
<b>4</b>			
<b>Statistics</b>			<b>188</b>
	4.1	Introduction	190
	4.2	Measures of Central Tendency	190
	4.3	Measures of Dispersion	203
	4.4	Measures of Position (Percentiles)	212
	4.5	Pictures of Data	218
	4.6	The Normal Curve	233
		Summary	247
		Vocabulary Check	248
		Review Exercises for Chapter 4	248
		Chapter Quiz	250
<b>5</b>			
<b>An Introduction to the Metric System</b>			<b>254</b>
	5.1	Introduction	256
	5.2	History of Systems of Measurement	260
	5.3	Length and Area	265
	5.4	Volume	273
	5.5	Mass (Weight)	279

	5.6	Temperature	284
		Summary	290
		Vocabulary Check	291
		Review Exercises for Chapter 5	292
		Chapter Quiz	293
<b>6</b>			
<b>Mathematical Systems</b>			296
	6.1	Introduction	298
	6.2	Clock Arithmetic	298
	6.3	More New Systems	310
	6.4	Modular Systems	315
	6.5	Mathematical Systems Without Numbers	322
	6.6	Axiomatic Systems	329
		Summary	335
		Vocabulary Check	336
		Review Exercises for Chapter 6	336
		Chapter Quiz	337
<b>7</b>			
<b>Systems of Numeration</b>			340
	7.1	Introduction	342
	7.2	Simple Grouping Systems	343
	7.3	Multiplicative Grouping Systems	349
	7.4	Place-Value Systems	353
	7.5	Numeration in Bases Other Than 10	359
	7.6	Base 5 Arithmetic	366
	7.7	Binary Notation and Other Bases	378
		Summary	387
		Vocabulary Check	388
		Review Exercises for Chapter 7	388
		Chapter Quiz	390
<b>8</b>			
<b>Sets of Numbers and Their Structure</b>			392
	8.1	Introduction	394
	8.2	Natural Numbers—Primes and Composites	394
	8.3	Greatest Common Divisor and Least Common Multiple	402
	8.4	Integers	410
	8.5	Rational Numbers	423
	8.6	Rational Numbers and Decimals	432
	8.7	Irrational Numbers and the Set of Real Numbers	442
	8.8	Scientific Notation (Optional)	446
		Summary	452

	Vocabulary Check	452
	Review Exercises for Chapter 8	453
	Chapter Quiz	454
<b>9</b>		
<b>An Introduction to Algebra</b>		456
9.1	Introduction	458
9.2	Open Sentences and Their Graphs	458
9.3	Algebraic Notation	464
9.4	More Open Sentences	467
9.5	Problem Solving	472
9.6	Linear Equations in Two Variables	482
9.7	Graphing Equations	487
9.8	The Slope of a Line (Optional)	497
9.9	The Equation of a Straight Line (Optional)	505
9.10	Graphing $y = ax^2 + bx + c$	518
9.11	Inequalities in Two Variables	522
9.12	Linear Programming	528
9.13	Quadratic Equations (Optional)	535
	Summary	541
	Vocabulary Check	542
	Review Exercises for Chapter 9	543
	Chapter Quiz	545
<b>10</b>		
<b>An Introduction to Geometry</b>		546
10.1	Introduction	548
10.2	Points and Lines	548
10.3	Planes	554
10.4	Angles	560
10.5	Polygons	572
10.6	Perimeter and Area	583
10.7	Solids	595
10.8	Congruent and Similar Triangles	606
10.9	Networks	612
	Summary	616
	Vocabulary Check	617
	Review Exercises for Chapter 10	618
	Chapter Quiz	619
<b>11</b>		
<b>Consumer Mathematics</b>		622
11.1	Introduction	624
11.2	Ratio and Proportion	624
11.3	Percents, Decimals, and Fractions	630
11.4	Markups and Markdowns	636



	11.5	Simple Interest	645
	11.6	Compound Interest	650
	11.7	Effective Rate of Interest	656
	11.8	Life Insurance	661
	11.9	Installment Plans and Mortgages	666
		Summary	674
		Vocabulary Check	675
		Review Exercises for Chapter 11	675
		Chapter Quiz	677
<b>12</b>			
<b>An Introduction to Computers</b>			<b>680</b>
	12.1	Introduction	682
	12.2	History of Computers	684
	12.3	How a Computer System Works	694
	12.4	Using BASIC	700
	12.5	More BASIC Statements	710
		Summary	717
		Vocabulary Check	718
		Review Exercises for Chapter 12	718
		Chapter Quiz	719
		<b>Glossary</b>	<b>721</b>
		<b>Appendix</b>	<b>729</b>
	Table 1	Factorials	729
	Table 2	Squares, Square Roots, and Prime Factors (1–100)	730
		<b>Answers to Odd-Numbered Exercises, All Review Exercises, and Chapter Quizzes</b>	<b>731</b>
		<b>Index</b>	<b>785</b>

# 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  $B$ .

## 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 $B$
$a \mid b$	$a$ such that $b$
$N!$	$n$ factorial $n! = n \times (n - 1) \times \dots \times 3 \times 2 \times 1$