Second Edition

Technical Mathematics

PAUL CALTER

Annotated Instructor's Edition

ANNOTATED INSTRUCTOR'S EDITION

Second Edition

TECHNICAL MATHEMATICS

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Annotated Instructor's Edition
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To Margaret Jolind

TO THE INSTRUCTOR

The first section of this Annotated Instructor's Edition is for you only. You can recognize this section by the red banner across the top of each page. The organization is as follows:

Following the special instructor's section is the complete student text with marginal notes and answers printed in red.

PREFACE

Most of the ideas for this second edition come from the classroom. Teaching from the first edition daily for seven years, I have listened to students, observed what worked and did not, and took notes. My colleagues did the same, and all comments and suggestions were carefully saved. Most of this material was completely revised four years ago for another project, and now it has been revised again for this edition. Each revision was aided by the many reviewers obtained by Prentice Hall.

My "finished" manuscript received yet another round of reviews, including a scrutiny by a developmental editor with a mathematics teaching background and was revised once more. It was then taken in hand by a team of editors and designers at Prentice Hall who made the book as attractive, useable, and error free as possible. Those who took part in this long project are listed in the acknowledgements. They have my sincere thanks.

This book is intended for students at technical schools or two-year technical colleges. Depending on the pace and the amount of material included, it may be used for either a one- or two-semester course.

We start with *Numerical Computation*. In addition to arithmetic, other topics in Chapter 1 include calculator operations, significant digits and rounding, scientific notation, and conversion of units. Some of these may be unfamiliar to high school graduates.

Many instructors will want to start with *Introduction to Algebra,* Chapter 2, and proceed through *Complex Numbers,* Chapter 20. Following these are several chapters of precalculus material from which to choose, as time allows.

FEATURES OF THE BOOK

A mathematics book is never easy reading, so much care has gone into making the material as clear as possible. We follow an intuitive rather than a rigorous approach and give information in small segments. Marginal notes, many illustrations, and careful page layout are designed to make the material as interesting and easy to follow as possible. The book also has the following features:

CHAPTER OBJECTIVES: Each chapter starts with a list of goals. They state what the student should be able to do upon completion of the chapter.

EXAMPLES: Many fully worked out examples form the backbone of the textbook. They have been specially chosen to help the student do the exercises. We have added dozens of examples to supplement those found in the first edition. Examples now have lines above and below to separate them clearly from the text discussion.

EXERCISES AND CHAPTER REVIEW PROBLEMS: Practice is essential for learning mathematics, and so we include thousands of exercises and chapter review problems. *Exercises* after each section are graded by difficulty and grouped by type to allow practice on a particular area. However, the *chapter review problems* are scrambled as to type and difficulty. Exercises are now labeled by category, as well as by exercise number. We give answers to all odd-numbered exercises and problems in the *Answer Key,* Appendix E. Complete solutions to every exercise and problem are contained in the *Solutions Manual,* available to instructors. Complete solutions for every other odd exercise and problem are given in the *Student Solutions Manual.*

FORMULAS: Each important formula, both mathematical and technical, is boxed and numbered in the text. We also list these formulas in Appendix A as the *Summary of Facts and Formulas*. This listing can function as a handbook for a mathematics course and for other courses as well. It provides a common thread between chapters. We hope it also will help a student to see connections that might otherwise be overlooked. The formulas are grouped logically in the *Summary of Facts and Formulas* and are numbered sequentially. Therefore, the formulas do not necessarily appear in the text in numerical order.

COMMON ERROR BOXES: An instructor quickly learns the pitfalls and traps that "get" students year after year. Many of these are boxed in the text and are labeled *Common Error*.

APPLICATIONS: We include discussion of many technical applications, such as motion problems and electric circuits. They are included for classes

that wish to cover those topics and to show that mathematics has real-world uses. Because space does not permit a full discussion of each application, judgment must be used in assigning applications problems. It is not intended that every student be able to solve every application. We assume that students will have sufficient background before they attempt difficult problems in their technical area and that they will get help from their instructors. The *Index to Applications* should help in finding specific applications.

NUMERICAL METHODS AND COMPUTER: As numerical methods and the computer grow in importance we continue to add these topics. However they can be skipped without impairing the overall study of technical mathematics. For those calculations that are best done by computer we give computer methods in the text itself. Elsewhere, computer problems are suggested at the end of exercises, as enrichment activities. The following numerical methods are included in the second edition:

- Roots of equations by the midpoint method
- Roots of equations by the false position method
- Roots of equations by simple iteration
- Roots of equations by Newton's method
- Solving systems of equations by the Gauss-Seidel method
- Evaluation of determinants by the method of Chió
- Solving sets of equations by Gauss Elimination
- Solving sets of equations by the unit matrix method
- Solving sets of equations by matrix inversion

As with technical applications, space does not permit the teaching of programming here, and we assume that a student who tries these has some computer background. We do, however, provide a *Summary of the Basic Language* in Appendix D. Complete programs are given in the solutions manual. A diskette containing all the programs is available to instructors, who may copy it for their students.

WRITING ACROSS THE CURRICULUM: There is a movement among mathematics teachers to use writing to help teach mathematics. Practice questions for mathematics requiring written responses are hard to find. We have provided one such question per chapter. These questions can be assigned as homework or can be used as models by instructors who wish to design others.

NEW MATERIAL: The content of the book is greatly expanded from the first edition. There are new chapters on

Matrices
Radian measure and arc length
Binary, hexadecimal, octal, and BCD numbers

Sequences, series, and the binomial theorem
Statistics and probability

And new sections on:

Higher order determinants
Exponents
The sine wave as a function of time
Graphing parametric equations
Graphing parametric equations in polar form
Graphs on logarithmic and semilogarithmic paper
Linear programming

There are also new topics in numerical methods and the computer, mentioned earlier.

TEACHING RESOURCES

There are a number of supplemental teaching resources to aid both the instructor and the student.

An *Annotated Instructor's Edition* (*AIE*) of this text contains answers to every exercise and problem. The answers, provided and checked by Susan Porter and Linda Davis of Vermont Technical College, are printed in red right next to the exercise or problem. The AIE also has marginal notes to the instructor (also printed in red), giving teaching tips, applications, and practice problems, and an introductory section giving tips on how to get the most from the text. All of this material has been prepared by Pat Hirschy of Delaware Technical College.

An *Instructor's Solutions Manual* contains worked-out solutions to every problem in the text and listings of all computer programs.

The *Student Solutions Manual,* by John Knox of Vermont Technical College, gives the solution to every other odd problem. They are usually worked in more detail than in the *Instructor's Solutions Manual.*

The *Supplementary Problems for Technical Mathematics,* by Michael Calter, Teaching Fellow at Harvard University, is useful for students who need more practice problems.

How To Study Technical Mathematics, by Paul Dudenhefer of State Technical Institute at Memphis, is a short booklet that provides encouragement, motivation, and strategies for the beginning technical mathematics student. Adopters of the text may request a free copy for each student.

A *Computerized Test Item File,* by Michael Calter, is a bank of test questions, with answers. Questions may be mixed, sorted, changed, or deleted. It consists of a test file disk and a test generator disk, ready to run on IBM PC's or compatibles.

Software Tools, by Nathan O. Niles and Al Parish, contains programs to enhance concepts covered in the text. It is self-contained, ready to run, and available in IBM PC and Apple Macintosh formats.

A *Computer Solutions Disk,* by Michael Calter, contains each program from the text, ready to run.

Transparency Acetates, giving additional problems and full explanations, are available.

Transparency Masters provide 378 enlarged drawings from the text.

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As mentioned at the beginning of the preface, this text, in its final form, is the result of an intensive developmental effort, in which many people took part. There are reviewers of the manuscripts of this edition and of the first edition, teachers of technical mathematics who participated in group discussions on how to improve the manuscript, teachers of writing who helped with the writing questions, checkers who solved problems and did proofreading, and so on.

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Paul Calter
Randolph, Vermont

ABOUT THE AUTHOR

Paul Calter is Professor of Mathematics at Vermont Technical College. A graduate of The Cooper Union, New York, he received his M.S. from Columbia University.

Professor Calter, a member of the American Society of Mechanical Engineers, has been teaching Technical Mathematics for over twenty years. In 1987, he was the recipient of the Vermont State College Faculty Fellow Award.

A member of the American Mathematical Association of Two Year Colleges, Professor Calter is the Chairman of the AMATYC Summer Institute in Vermont. He is also a member of the Mathematical Association of America, the Society for Technical Communication, Volunteers in Technical Assistance, and the Author's Guild.

Professor Calter is the author of several mathematics textbooks, among which is the *Schaum's Outline of Technical Mathematics*. With Prentice Hall he has published three other books: *Practical Math Handbook for the Building Trades, Mathematics for Computer Technology,* and *Technical Calculus*. He has also published research articles in engineering journals.

He resides in rural Vermont and is an accomplished sculptor. His work often reflects themes related to mathematics.