

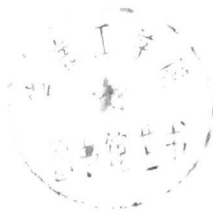
Mathematics Applied to Electronics

James H. Harter / Wallace D. Beitzel

TN01
H3

8163512

Mathematics applied to Electronics



JAMES H. HARTER

Los Angeles Harbor College

WALLACE D. BEITZEL

TRW Defense and Space Systems Group

Marolyn Young, *Technical Illustrator*



E8163512

2166918

Library of Congress Cataloging in Publication Data

HARTER, JAMES H

Mathematics applied to electronics.

Includes index.

1. Electronics—Mathematics. I. Beitzel, Wallace D., joint author. II. Title.

TK7835.H28 512'.1'0246213 79-25895

ISBN 0-8359-4288-0

© 1980 by James H. Harter & Wallace D. Beitzel

All rights reserved.

No part of this book may be reproduced
in any way or by any means,
without permission in writing from the publisher.

10 9 8 7 6 5 4 3 2 1

Printed in the United States of America

Mathematics
applied to
Electronics

2180008



RESTON PUBLISHING COMPANY

A Prentice-Hall Company

Reston, Virginia 22090

PREFACE

This book is designed to be used by those seeking an understanding of mathematics as it is applied to electronics. This may be in a formal setting such as a community college or in a self-study program. *Mathematics Applied to Electronics* is intended to be used by those studying to be specialists in applying the technology of electronics to achieve practical ends.

The electronics curriculum for which this book is written usually needs the support of a large and diverse amount of mathematics. The contents of a mathematics book for electronics is, therefore, based on a "trade off" between a detailed, formal, proof orientation and the need for expediency in developing a broad, general mathematics ability.

The sequence of the chapters and of the topics within each chapter has been planned both to be as vital as possible and to be compatible with the circuits books currently in use. The text provides the reader with a wide exposure to mathematics while still expediting the learning process. This process is enhanced through the use of the calculator, which is an integral part of this text. It is intended that a calculator be used whenever calculations are performed.

The early chapters of the text include selected topics from pre-algebra. The purpose of these initial chapters is twofold: first, to introduce the use of the calculator at the onset of the text; second, to focus attention on specific electronics-related mathematical topics at a level easily comprehended—thus providing the reader with a positive reinforcement in his study of mathematics as applied to electronics. This positive reinforcement may help keep the student in the class long enough for the instructor to provide additional motivation.

These early chapters are followed by several dealing with the mechanics of algebra, including the evaluation of formulas. This series of chapters culminates with a chapter devoted to equations in one unknown.

Each section of theoretical chapters is followed by one or more application chapters. The application chapters

serve to reinforce what has been presented previously and to provide the reader with that all-important opportunity to transfer his mathematical skills to electronic concepts.

Interspersed throughout the book are chapters and topics dealing with analytical geometry. These chapters are essential because graphic concepts are important to the electronics industry and so much valuable information is presented in graphical form.

The transcendental functions are covered after the algebraic functions. Included in these chapters are the logarithmic, exponential, and trigonometric functions. These topics are followed by a series of chapters covering the mathematics of alternating current. The text concludes with chapters dealing with math analysis and number systems. These final chapters are directed to those who need a preparation for the study of calculus and computer number systems.

This text is designed to help the reader to teach himself and in this way provides a means of coordinating the instruction in the classroom with the outside assignments. The reader is guided by hundreds of detailed examples, figures, and problems. The use of SI units throughout the text will enable him to make an easy transition to any of the modern circuits books that use the SI metric system.

The authors wish to thank Professor Frank Sonico for his helpful comments and suggestions, Janet Garrick for her assistance in typing portions of the manuscript, and Marolyn Young for her extraordinary effort in the preparation of the illustrations. We would also like to acknowledge and thank Marjorie Streeter for her imaginative design and expert coordination of the production of the text. Finally, we make special acknowledgment of Faybeth Harter for her typing of the initial and final copies of the manuscript, for her dedication in keeping the vocabulary and reading level simplified, and for her many suggestions during the preparation and editing of the manuscript.

James Harter
Wallace Beitzel

CONTENTS

PREFACE

xiii

1

Surviving Mathematics

1

- 1-1 YOU, 2
- 1-2 THE SCOPE AND STRUCTURE OF THE TEXT, 2
- 1-3 THE LEARNING PROCESS, 3
- 1-4 STUDY AND SURVIVAL, 3
- 1-5 SELECTING A CALCULATOR, 4
- 1-6 ASSUMPTIONS MADE BY US ABOUT YOU, 4
- 1-7 GENERAL INFORMATION, 4

2

Selected Prealgebra Topics

7

- 2-1 NATURAL NUMBERS AND NUMBER SYSTEMS, 8
- 2-2 SIGNED NUMBERS, 9
- 2-3 NUMERICAL EXPRESSIONS AND EQUATIONS, 10
- 2-4 ORDER OF OPERATION, 12
- 2-5 SYMBOLS OF GROUPING, 14
- 2-6 DOUBLE MEANING OF + AND -, 15
- 2-7 ABSOLUTE VALUE OF A SIGNED NUMBER, 16
- 2-8 COMBINING SIGNED NUMBERS, 17
- 2-9 RELATIONAL OPERATORS, 21
- 2-10 MULTIPLYING WITH SIGNED NUMBERS, 22
- 2-11 DIVIDING WITH SIGNED NUMBERS, 25
- 2-12 INTRODUCTION TO EXPONENTS, 27

3

Number Notation and Operation

29

- 3-1 POWERS OF TEN NOTATION, 30
- 3-2 SCIENTIFIC NOTATION AND DECIMAL NOTATION, 33
- 3-3 SIGNIFICANT FIGURES AND ROUNDING, 37
- 3-4 MULTIPLICATION WITH POWERS OF TEN, 38
- 3-5 DIVISION WITH POWERS OF TEN, 41
- 3-6 POWERS, PRODUCTS, AND FRACTIONS RAISED TO POWERS, 43

<i>vi</i>	3-7 SQUARE ROOTS AND RADICALS, 46
<i>Contents</i>	3-8 RECIPROCALs, 49
	3-9 COMBINED OPERATIONS, 51
	3-10 APPROXIMATIONS, 52
	3-11 EXPONENTIAL NOTATION, 54
4	
Algebra	4-1 VARIABLES, SUBSCRIPTS, AND PRIMES, 58
Fundamentals I	4-2 INDICATING MULTIPLICATION, 60
57	4-3 GENERAL NUMBER, 60
	4-4 ALGEBRAIC EXPRESSIONS, 61
	4-5 PRODUCTS, FACTORS, AND COEFFICIENTS, 63
	4-6 COMBINING LIKE TERMS, 63
	4-7 POLYNOMIALS, 64
	4-8 ADDING POLYNOMIALS, 65
5	
Algebra	5-1 MULTIPLYING MONOMIALS, 70
Fundamentals II	5-2 MULTIPLYING A MONOMIAL AND A BINOMIAL, 72
69	5-3 MULTIPLYING A MONOMIAL AND A POLYNOMIAL, 73
	5-4 SUBTRACTING POLYNOMIALS, 74
	5-5 ADDITIONAL WORK WITH POLYNOMIALS, 76
	5-6 DIVISION OF MONOMIALS, 77
	5-7 DIVIDING A POLYNOMIAL BY A MONOMIAL, 78
	5-8 FACTORING POLYNOMIALS WITH A COMMON MONOMIAL FACTOR, 80
	5-9 EVALUATING ALGEBRAIC EXPRESSIONS, 81
6	
Solving	6-1 EQUATIONS, 84
Equations	6-2 FINDING THE ROOT OF AN EQUATION, 85
83	6-3 USING ADDITION TO TRANSFORM EQUATIONS, 85
	6-4 USING MULTIPLICATION TO TRANSFORM EQUATIONS, 87
	6-5 ADDITIONAL PRACTICE IN SOLVING EQUATIONS, 89
	6-6 EQUATIONS CONTAINING PARENTHESES, 92
	6-7 SOLVING FORMULAS, 93
	6-8 FORMING EQUATIONS, 96
	6-9 SOLVING WORD PROBLEMS, 97
7	
Quantities and	7-1 SYSTEMS OF MEASUREMENT, 102
Units of	7-2 THE SI SYSTEM OF MEASUREMENT, 103
Measurement	7-3 DETAILS OF SELECTED PHYSICAL QUANTITIES, 104
101	7-4 FORMING DECIMAL MULTIPLES AND SUBMULTIPLES OF THE SI UNITS, 108
	7-5 EVALUATING FORMULAS, 111
	7-6 UNIT ANALYSIS AND CONVERSION BETWEEN SYSTEMS, 113
8	
Applying	8-1 CURRENT, VOLTAGE, AND RESISTANCE, 120
Mathematics to	8-2 OHM'S LAW, 126
Electrical Circuits	8-3 RESISTANCE IN A SERIES CIRCUIT, 129
119	8-4 APPLYING OHM'S LAW TO SERIES CIRCUITS, 132
	8-5 SUMMARY OF THE SERIES CIRCUIT, 135

9	
Applying Mathematics to Electrical Concepts	
139	
	9-1 POWER, 140
	9-2 EFFICIENCY, 144
	9-3 COST OF ELECTRICAL ENERGY, 149

10	
Fractions	
153	
	10-1 INTRODUCTORY CONCEPTS, 154
	10-2 FORMING EQUIVALENT FRACTIONS, 155
	10-3 SIMPLIFYING FRACTIONS, 157
	10-4 MULTIPLYING FRACTIONS, 158
	10-5 DIVIDING FRACTIONS, 160
	10-6 COMPLEX FRACTIONS, 162
	10-7 ADDING AND SUBTRACTING FRACTIONS, 164
	10-8 CHANGING A MIXED EXPRESSION TO A FRACTION, 172
	10-9 ADDITIONAL WORK WITH COMPLEX FRACTIONS, 173

11	
Equations Containing Fractions	
177	
	11-1 SOLVING EQUATIONS CONTAINING FRACTIONS, 178
	11-2 SOLVING FRACTIONAL EQUATIONS, 180
	11-3 LITERAL EQUATIONS CONTAINING FRACTIONS, 182
	11-4 EVALUATING FORMULAS, 184

12	
Application of Fractions	
189	
	12-1 RATIO, PERCENT, AND PARTS PER MILLION, 190
	12-2 PROPORTION, 195
	12-3 ELECTRICAL CONDUCTORS, 196

13	
Applying Fractions to Electrical Circuits	
207	
	13-1 VOLTAGE DIVISION IN A SERIES CIRCUIT, 208
	13-2 CONDUCTANCE OF THE PARALLEL CIRCUIT, 211
	13-3 EQUIVALENT RESISTANCE OF THE PARALLEL CIRCUIT, 214
	13-4 CURRENT DIVISION IN THE PARALLEL CIRCUIT, 216
	13-5 SOLVING PARALLEL CIRCUIT PROBLEMS, 218

14	
Relations and Functions	
223	
	14-1 MEANING OF A FUNCTION, 224
	14-2 VARIABLES AND CONSTANTS, 224
	14-3 FUNCTIONAL NOTATION, 226
	14-4 FUNCTIONAL VARIATION, 228
	14-5 SIMPLIFYING FORMULAS, 231

15	
Graphs and Graphing Techniques	
235	
	15-1 RECTANGULAR COORDINATES, 236
	15-2 GRAPHS OF EQUATIONS, 240
	15-3 GRAPHS OF LINEAR EQUATIONS, 244
	15-4 DERIVING A LINEAR EQUATION FROM A GRAPH, 250
	15-5 GRAPHING EMPIRICAL DATA, 253

16	Solving Systems of Linear Equations	257	16-1 GRAPHIC METHOD, 258 16-2 ADDITION OR SUBTRACTION METHOD, 260 16-3 SUBSTITUTION METHOD, 263 16-4 DERIVING ELECTRICAL FORMULAS, 265 16-5 DETERMINANTS OF THE SECOND ORDER, 266 16-6 DETERMINANTS OF THE THIRD ORDER, 271
17	Applying Graphs to Electronic Concepts	277	17-1 GRAPHIC ESTIMATION OF STATIC PARAMETERS, 278 17-2 GRAPHIC ESTIMATION OF DYNAMIC PARAMETERS, 282 17-3 GRAPHIC ANALYSIS OF NON-LINEAR CIRCUITS, 287
18	Applying Systems of Linear Equations to Electronic Concepts	293	18-1 APPLYING KIRCHHOFF'S VOLTAGE LAW, 294 18-2 MESH ANALYSIS, 299 18-3 SOLVING NETWORKS BY MESH ANALYSIS, 304
19	Special Products, Factoring, and Equations	311	19-1 MENTALLY MULTIPLYING TWO BINOMIALS, 312 19-2 PRODUCT OF THE SUM AND DIFFERENCE OF TWO NUMBERS, 314 19-3 SQUARE OF A BINOMIAL, 315 19-4 FACTORING THE DIFFERENCE OF TWO SQUARES, 317 19-5 FACTORING A PERFECT TRINOMIAL SQUARE, 317 19-6 FACTORING BY GROUPING, 318 19-7 COMBINING SEVERAL TYPES OF FACTORING, 319 19-8 LITERAL EQUATIONS, 321
20	Solving Quadratic Equations	323	20-1 INTRODUCTION, 324 20-2 SOLVING INCOMPLETE QUADRATIC EQUATIONS, 324 20-3 SOLVING COMPLETE QUADRATIC EQUATIONS, 326 20-4 SOLVING QUADRATIC EQUATIONS BY THE QUADRATIC FORMULA, 329 20-5 GRAPHING THE QUADRATIC FUNCTION, 332 20-6 APPLYING THE TECHNIQUES OF SOLVING QUADRATIC EQUATIONS TO ELECTRONIC PROBLEMS, 339
21	Exponents, Radicals, and Equations	343	21-1 LAWS OF EXPONENTS, 344 21-2 ZERO AND NEGATIVE INTEGERS AS EXPONENTS, 345 21-3 FRACTIONAL EXPONENTS, 346 21-4 LAWS OF RADICALS, 348 21-5 SIMPLIFYING RADICALS, 349 21-6 RADICAL EQUATIONS, 352
22	Logarithmic and Exponential Functions	355	22-1 COMMON LOGARITHMS, 356 22-2 COMMON LOGARITHMIC AND SCIENTIFIC NOTATION, 357 22-3 ANTILOGARITHMS, 360 22-4 LOGARITHMS, PRODUCTS, AND QUOTIENTS, 361 22-5 LOGARITHMS, POWERS, AND RADICALS, 363 22-6 NATURAL LOGARITHMS, 366
viii			

<i>ix</i>	22-7	CHANGING BASE, 369
<i>Contents</i>	22-8	FURTHER PROPERTIES OF NATURAL LOGARITHMS, 370
	22-9	LOG EQUATIONS, 371
	22-10	EXPONENTIAL EQUATIONS, 373
	22-11	SEMILOG AND LOG-LOG PLOTS, 374
	22-12	NOMOGRAPHS, 376

23

Applications of
Logarithmic and
Exponential Equations
to Electronic Concepts
379

23-1	THE DECIBEL, 380
23-2	SYSTEM CALCULATIONS, 383
23-3	RC AND RL TRANSIENT BEHAVIOR, 388

24

Angles and
Triangles
395

24-1	POINTS, LINES, AND ANGLES, 396
24-2	SPECIAL ANGLES, 399
24-3	TRIANGLES, 400
24-4	RIGHT TRIANGLES AND THE PYTHAGOREAN THEOREM, 402
24-5	SIMILAR TRIANGLES; TRIGONOMETRIC FUNCTIONS, 404
24-6	USING THE TRIGONOMETRIC FUNCTIONS TO SOLVE RIGHT TRIANGLES, 406
24-7	INVERSE TRIGONOMETRIC FUNCTIONS, 409
24-8	SOLVING RIGHT TRIANGLES WHEN TWO SIDES ARE KNOWN, 410

25

Circular
Functions
413

25-1	ANGLES OF ANY MAGNITUDE, 414
25-2	CIRCULAR FUNCTIONS, 415
25-3	GRAPHS OF THE CIRCULAR FUNCTIONS, 417
25-4	INVERSE CIRCULAR FUNCTIONS, 419
25-5	POLAR COORDINATES, 420
25-6	CONVERTING BETWEEN RECTANGULAR AND POLAR COORDINATES, 422

26

Vectors and
Phasors
425

26-1	SCALARS AND VECTORS, 426
26-2	COMPLEX PLANE, 426
26-3	REAL AND IMAGINARY NUMBERS, 427
26-4	COMPLEX NUMBERS, 428
26-5	PHASORS, 431
26-6	TRANSFORMING COMPLEX NUMBER FORMS, 433
26-7	RESOLVING SYSTEMS OF PHASORS AND VECTORS, 436

27

The Mathematics
of Phasors
441

27-1	ADDITION AND SUBTRACTION OF PHASOR QUANTITIES, 442
27-2	MULTIPLICATION OF PHASOR QUANTITIES, 444
27-3	DIVISION OF PHASOR QUANTITIES, 447
27-4	POWERS AND ROOTS OF PHASOR QUANTITIES, 450

28

Fundamentals of
Alternating Currents
453

28-1	ALTERNATING CURRENT TERMINOLOGY, 454
28-2	RESISTANCE, 256
28-3	INDUCTANCE AND INDUCTIVE REACTANCE, 458
28-4	CAPACITANCE AND CAPACITIVE REACTANCE, 462
28-5	VOLTAGE PHASOR FOR SERIES CIRCUITS, 465
28-6	CURRENT PHASOR FOR PARALLEL CIRCUITS, 473

29

Alternating- Current Circuits 479

- 29-1 IMPEDANCE OF SERIES AC CIRCUITS, 480
- 29-2 SOLVING SERIES AC CIRCUITS, 488
- 29-3 ADMITTANCE CONCEPTS, 494
- 29-4 ADMITTANCE OF PARALLEL AC CIRCUITS, 497

30

Sinusoidal Alternating Current 505

- 30-1 TIME AND DISPLACEMENT, 506
- 30-2 POWER AND POWER FACTOR, 510
- 30-3 INSTANTANEOUS EQUATIONS AND THE EI PHASOR DIAGRAM, 516

31

Additional Trigonometric and Exponential Functions 521

- 31-1 AUXILIARY TRIGONOMETRIC FUNCTIONS, 522
- 31-2 GRAPHS OF THE AUXILIARY TRIGONOMETRIC FUNCTIONS, 523
- 31-3 TRIGONOMETRIC IDENTITIES, 525
- 31-4 HYPERBOLIC FUNCTIONS, 526
- 31-5 GRAPHING THE HYPERBOLIC FUNCTIONS, 528
- 31-6 HYPERBOLIC IDENTITIES, 528
- 31-7 INVERSE HYPERBOLIC FUNCTIONS, 529

32

Mathematical Analysis 533

- 32-1 DOMAIN AND RANGE, 534
- 32-2 DISCONTINUITIES, 534
- 32-3 FUNCTIONS OF LARGE NUMBERS, 539
- 32-4 ASYMPTOTES, 541

33

Number Systems 545

- 33-1 DECIMAL NUMBER SYSTEMS, 546
- 33-2 THREE ADDITIONAL NUMBER SYSTEMS, 547
- 33-3 CONVERTING NUMBERS TO THE DECIMAL SYSTEM, 550
- 33-4 CONVERTING DECIMAL NUMBERS TO OTHER SYSTEMS, 552
- 33-5 CONVERTING BETWEEN BINARY, OCTAL, AND HEXADECIMAL, 556
- 33-6 BINARY ADDITION AND SUBTRACTION, 558
- 33-7 OCTAL ADDITION AND SUBTRACTION, 560
- 33-8 HEXADECIMAL ADDITION AND SUBTRACTION, 562
- 33-9 COMPLEMENTS, 564
- 33-10 BINARY ARITHMETIC WITH COMPLEMENTS, 568

APPENDIX A Reference Tables 573

APPENDIX B Answers to Selected Problems 576

INDEX 623

1

Surviving Mathematics

- 1-1 YOU
- 1-2 SCOPE AND STRUCTURE OF THE TEXT
- 1-3 THE LEARNING PROCESS
- 1-4 STUDY AND SURVIVAL
- 1-5 SELECTING A CALCULATOR
- 1-6 ASSUMPTIONS MADE BY US ABOUT YOU
- 1-7 GENERAL INFORMATION

This chapter is intended to help you to “*survive*” the educational process. More specifically, it is to help you survive mathematics applied to electronics. An overview of the scope and structure is presented. Assistance is offered in helping you to select a calculator. Then, we let you in on the assumptions that we have made about you.

1-1 “YOU”

“You are the best you there is.” Be kind to yourself and read through this chapter. It is written to give you an understanding of the text and how to survive the stress-producing process of becoming educated.

You are from varied backgrounds, of different ages, and have had different experiences, but all of you have a common goal—to learn more about “*mathematics applied to electronics*.” Give yourself a gift and listen to what we have to say to you.

1-2 THE SCOPE AND STRUCTURE OF THE TEXT

Scope

We have selected from the field of mathematics those topics that support your career goal in electronics. We have tailored the topics and have streamlined the presentation so that both the special needs of the technology are met and a reasonable level of instruction is maintained.

The text material starts at the prealgebra level, covers topics in algebra, number notation, units of measurement, and graphing; moves into systems of simultaneous equations, logarithmic functions, trigonometric functions, circular functions, mathematics of phasors, and dc and ac electronic circuits; and concludes with math analysis and number systems.

Structure

A gradual progression from the known to the unknown, from the simple to the complex is achieved in the sequencing of the chapters and the topics within each chapter. The rigorous, meticulous, in-depth pursuit of particular topics common to formal courses in mathematics is not found in this book. A particular topic may be introduced in the early section of the text and then reintroduced at a later time for a more detailed or in-depth application. By using this technique, a reinforcing of the concept is possible.

We have purposefully structured the book so that you will receive a positive feeling about the course you are taking. We have provided you with hundreds of detailed examples to make it possible for you to “learn on your own” and become responsible for educating yourself. If the class you are in is taught in a traditional lecture demonstration manner, then the self-educating aspects of the text may be used to prepare for the next day’s lesson and to assist in doing the assigned out-of-class work. In addition, if you have been absent, the material missed may be studied and mastered on an individual basis.

1-3 THE LEARNING PROCESS

The process of becoming educated is usually accompanied by a feeling of uncertainty. Learning a new idea for the first time, coupled with the experience of attending college, is very stressful. Many students face these situations and far too many fail in the first weeks of the semester because they were unable to "adjust" to the learning experience.

We as educators recognize these feelings and have made a conscious effort to keep the stress level down by:

1. Selecting only the topics necessary for a rounded exposure to mathematics as it applies to electronics.
2. Integrating the scientific calculator into the learning process.
3. Designing the presentation so that you may have sufficient time to become familiar with the ideas and learn the concepts.
4. Providing detailed examples, tables, illustrations, and explanations; thus sufficient information is presented in a variety of ways so that you will be interested and motivated.
5. Presenting the concepts in a clear, uncluttered manner reinforced with examples and graded problem sets.
6. Setting the reading level to communicate with you rather than to impress you or your instructor.

1-4 STUDY AND SURVIVAL

How, where, and when you study this text will greatly influence your survival of the educational process. If survival is in your plans, then prepare for class, do your homework, and study for your tests. You can "set yourself up to fail." You can make excuses and be preoccupied with "more important activities." You need to recognize that your education is your responsibility, not the responsibility of the instructor. Your survival in a course is dependent solely upon your choices of how, where, and when you study.

How Study by reading the material in each section. Work through each example with pencil, paper, and calculator. If you are to become educated, you must be an active participant in the process.

Where Study where you won't be distracted by friends, noise, or activities. Study where you will have all the materials needed for study. Remember, you must work through and write down the examples and problems. Success in mathematics comes by you *doing*, not by watching someone else.

When Study each day. As a student you have a very limited time with which to work. Most of you have full- or part-time jobs, families, and other commitments, which when coupled with going to school leaves very little time for study. You must understand that much of your education takes place outside the classroom. When you do required assignments that use pencil, paper, and a calculator, you are educating yourself by becoming an active

4 *Surviving Mathematics* participant in the educational process. As a rule, one to three hours of active study are needed to fully learn a new idea. To corrupt an old saying, "an hour a day, keeps drop-out away."

The object of education is to survive the process of becoming educated. The means of survival is through active study, participation, and preparation. Be kind to yourself by choosing to study daily.

1-5 SELECTING A CALCULATOR

First and foremost, purchase a name brand scientific calculator. Don't think that it's too expensive. You are worth it! An inadequate calculator will cost you time and energy that would be better spent elsewhere. Purchase a full-function calculator that is not programmable.

Table 1-1 lists the functions and operations that will be used in this text. As you may see from this list, there is a lot to learn about the calculator. Since the calculator will play a significant role in your education, buy a good one. The major manufacturers of calculators have reasonably priced instruments available that have all the functions and operations mentioned in Table 1-1.

Before purchasing, try out various calculators. Talk to the advanced students in your department about their calculators. Look at Table 1-1 to see which functions and operations are required. If you already have a calculator that has the capabilities introduced in Chapters 2 and 3, live with it before buying a new one.

1-6 ASSUMPTIONS MADE BY US ABOUT YOU

We have made several assumptions about you that we would like to share with you.

- ☐ We assume that you have mastered the skills of arithmetic, including adding, subtracting, multiplying, dividing, fractions (both decimal fractions and built-up fractions), and percentage.
- ☐ We assume that you will have a scientific calculator with you while studying this text. We have made provisions in the text for a lesser calculator, but if you are to get the most out of your education, the scientific calculator will be necessary.
- ☐ We assume that you have an active interest in the field of electronics.
- ☐ We assume that you will work through each example. A great deal of information has been included in the examples.
- ☐ We assume that you will have your owner's guide for your calculator available with your calculator.

1-7 GENERAL INFORMATION

In addition to the previous assumptions, you need to be aware of the following:

- ☐ The leading zero in decimal numbers as in 0.357 is used to set off the decimal point.