PREFACE

Formerly used mainly by specialists in signal processing and numerical analysis, MATLAB* in recent years has achieved widespread and enthusiastic acceptance throughout the engineering community. Many engineering schools now require a course based entirely or in part on MATLAB early in the curriculum. MATLAB is programmable and has the same logical, relational, conditional, and loop structures as other programming languages, such as Fortran, C, BASIC, and Pascal. Thus it can be used to teach programming principles. In most schools a MATLAB course has replaced the traditional Fortran course, and MATLAB is the principal computational tool used throughout the curriculum. In some technical specialties, such as signal processing and control systems, it is the standard software package for analysis and design.

The popularity of MATLAB is partly due to its long history, and thus it is well developed and well tested. People trust its answers. Its popularity is also due to its user interface, which provides an easy-to-use interactive environment that includes extensive numerical computation and visualization capabilities. Its compactness is a big advantage. For example, you can solve a set of many linear algebraic equations with just three lines of code, a feat that is impossible with traditional programming languages. MATLAB is also extensible; currently more than 20 "toolboxes" in various application areas can be used with MATLAB to add new commands and capabilities.

MATLAB is available for MS Windows and Macintosh personal computers and for other operating systems. It is compatible across all these platforms, which enables users to share their programs, insights, and ideas. This text is based on MATLAB version 7.9 (R2009b). Some of the material in Chapter 9 is based on the control system toolbox, Version 8.4. Chapter 10 is based on Version 7.4 of Simulink*. Chapter 11 is based on Version 5.3 of the Symbolic Math toolbox.

TEXT OBJECTIVES AND PREREQUISITES

This text is intended as a stand-alone introduction to MATLAB. It can be used in an introductory course, as a self-study text, or as a supplementary text. The text's material is based on the author's experience in teaching a required two-credit semester course devoted to MATLAB for engineering freshmen. In addition, the text can serve as a reference for later use. The text's many tables and its referencing system in an appendix have been designed with this purpose in mind.

*MATLAB and Simulink are registered trademarks of The MathWorks, Inc.

A secondary objective is to introduce and reinforce the use of problem-solving methodology as practiced by the engineering profession in general and as applied to the use of computers to solve problems in particular. This methodology is introduced in Chapter 1.

The reader is assumed to have some knowledge of algebra and trigonometry; knowledge of calculus is not required for the first seven chapters. Some knowledge of high school chemistry and physics, primarily simple electric circuits, and basic statics and dynamics is required to understand some of the examples.

TEXT ORGANIZATION

This text is an update to the author's previous text.* In addition to providing new material based on MATLAB 7, especially the addition of the MuPAD program, the text incorporates the many suggestions made by reviewers and other users.

The text consists of 11 chapters. The first chapter gives an overview of MATLAB features, including its windows and menu structures. It also introduces the problem-solving methodology. Chapter 2 introduces the concept of an array, which is the fundamental data element in MATLAB, and describes how to use numeric arrays, cell arrays, and structure arrays for basic mathematical operations.

Chapter 3 discusses the use of functions and files. MATLAB has an extensive number of built-in math functions, and users can define their own functions and save them as a file for reuse.

Chapter 4 treats programming with MATLAB and covers relational and logical operators, conditional statements, `for` and `while` loops, and the `switch` structure. A major application of the chapter's material is in simulation, to which a section is devoted.

Chapter 5 treats two- and three-dimensional plotting. It first establishes standards for professional-looking, useful plots. In the author's experience, beginning students are not aware of these standards, so they are emphasized. The chapter then covers MATLAB commands for producing different types of plots and for controlling their appearance.

Chapter 6 covers function discovery, which uses data plots to discover a mathematical description of the data. It is a common application of plotting, and a separate section is devoted to this topic. The chapter also treats polynomial and multiple linear regression as part of its modeling coverage.

Chapter 7 reviews basic statistics and probability and shows how to use MATLAB to generate histograms, perform calculations with the normal distribution, and create random number simulations. The chapter concludes with linear and cubic spline interpolation. The following chapters are not dependent on the material in this chapter.

**Introduction to MATLAB 7 for Engineers*, McGraw-Hill, New York, 2005.

Chapter 8 covers the solution of linear algebraic equations, which arise in applications in all fields of engineering. This coverage establishes the terminology and some important concepts required to use the computer methods properly. The chapter then shows how to use MATLAB to solve systems of linear equations that have a unique solution. Underdetermined and overdetermined systems are also covered. The remaining chapters are independent of this chapter.

Chapter 9 covers numerical methods for calculus and differential equations. Numerical integration and differentiation methods are treated. Ordinary differential equation solvers in the core MATLAB program are covered, as well as the linear system solvers in the Control System toolbox. This chapter provides some background for Chapter 10.

Chapter 10 introduces Simulink, which is a graphical interface for building simulations of dynamic systems. Simulink has increased in popularity and has seen increased use in industry. This chapter need not be covered to read Chapter 11.

Chapter 11 covers symbolic methods for manipulating algebraic expressions and for solving algebraic and transcendental equations, calculus, differential equations, and matrix algebra problems. The calculus applications include integration and differentiation, optimization, Taylor series, series evaluation, and limits. Laplace transform methods for solving differential equations are also introduced. This chapter requires the use of the Symbolic Math toolbox, which includes MuPAD. MuPAD is a new feature in MATLAB. It provides a notebook interface for entering commands and displaying results, including plots.

Appendix A contains a guide to the commands and functions introduced in the text. Appendix B is an introduction to producing animation and sound with MATLAB. While not essential to learning MATLAB, these features are helpful for generating student interest. Appendix C summarizes functions for creating formatted output. Appendix D is a list of references. Appendix E, which is available on the text's website, contains some suggestions for course projects and is based on the author's experience in teaching a freshman MATLAB course. Answers to selected problems and an index appear at the end of the text.

All figures, tables, equations, and exercises have been numbered according to their chapter and section. For example, Figure 3.4–2 is the second figure in Chapter 3, Section 4. This system is designed to help the reader locate these items. The end-of-chapter problems are the exception to this numbering system. They are numbered 1, 2, 3, and so on to avoid confusion with the in-chapter exercises.

The first four chapters constitute a course in the essentials of MATLAB. The remaining seven chapters are independent of one another, and may be covered in any order or may be omitted if necessary. These chapters provide additional coverage and examples of plotting and model building, linear algebraic equations, probability and statistics, calculus and differential equations, Simulink, and symbolic processing, respectively.

SPECIAL REFERENCE FEATURES

The text has the following special features, which have been designed to enhance its usefulness as a reference.

- Throughout each of the chapters, numerous tables summarize the commands and functions as they are introduced.
- Appendix A is a complete summary of all the commands and functions described in the text, grouped by category, along with the number of the page on which they are introduced.
- At the end of each chapter is a list of the key terms introduced in the chapter, with the page number referenced.
- Key terms have been placed in the margin or in section headings where they are introduced.
- The index has four sections: a listing of symbols, an alphabetical list of MATLAB commands and functions, a list of Simulink blocks, and an alphabetical list of topics.

PEDAGOGICAL AIDS

The following pedagogical aids have been included:

- Each chapter begins with an overview.
- **Test Your Understanding** exercises appear throughout the chapters near the relevant text. These relatively straightforward exercises allow readers to assess their grasp of the material as soon as it is covered. In most cases the answer to the exercise is given with the exercise. Students should work these exercises as they are encountered.
- Each chapter ends with numerous problems, grouped according to the relevant section.
- Each chapter contains numerous practical examples. The major examples are numbered.
- Each chapter has a summary section that reviews the chapter's objectives.
- Answers to many end-of-chapter problems appear at the end of the text. These problems are denoted by an asterisk next to their number (for example, **15***).

Two features have been included to motivate the student toward MATLAB and the engineering profession:

- Most of the examples and the problems deal with engineering applications. These are drawn from a variety of engineering fields and show realistic applications of MATLAB. A guide to these examples appears on the inside front cover.

- The facing page of each chapter contains a photograph of a recent engineering achievement that illustrates the challenging and interesting opportunities that await engineers in the 21st century. A description of the achievement and its related engineering disciplines and a discussion of how MATLAB can be applied in those disciplines accompanies each photo.

ONLINE RESOURCES

An Instructor's Manual is available online for instructors who have adopted this text. This manual contains the complete solutions to all the **Test Your Understanding** exercises and to all the chapter problems. The text website (at http://www.mhhe.com/palm) also has downloadable files containing PowerPoint slides keyed to the text and suggestions for projects.

ELECTRONIC TEXTBOOK OPTIONS

Ebooks are an innovative way for students to save money and create a greener environment at the same time. An ebook can save students about one-half the cost of a traditional textbook and offers unique features such as a powerful search engine, highlighting, and the ability to share notes with classmates using ebooks.

McGraw-Hill offers this text as an ebook. To talk about the ebook options, contact your McGraw-Hill sales rep or visit the site www.coursesmart.com to learn more.

MATLAB INFORMATION

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