A Brief Introduction to Engineering Computation with MATLAB

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C O N N E X I O N S

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Preface[1]

IN MY TENTH YEAR AT THE INSTITUTE, I DEDICATE THIS BOOK TO THE BCIT COMMUNITY.

The primary purpose of writing a book and distributing it free-of-charge is to extend my gratitude to BCIT[2] . I am particularly thrilled to do it with this textbook because it is a product of many learning opportunities BCIT has offered me over a period of several years. What follows is a brief background on how this book came to be.

My post-secondary teaching career began on 22 January 2001 at the Pacific Marine Training Campus of BCIT when I logged on to a Unix workstation to instruct in the Propulsion Plant Simulator. That has been a major milestone in many ways in my professional life. While learning inner workings of Unix operating system (OS), I also made a discovery and that discovery profoundly changed my view on how I thought the world operated. The discovery was the GNU/Linux OS and open source software (OSS) movement through several books, most notably Just for Fun: The Story of an Accidental Revolutionary[3] and The Cathedral and the Bazaar[4]. I was convinced that the collective power of connected individuals around the world and the global infrastructure of the Internet had the potential to change the ways the world functioned.

In the last 10 years, BCIT has allowed me to study various subjects through its Professional Development (PD) programs for which I am very grateful. I learned a great deal in PD courses and in one of the recent ones, I had two déjà vu moments similar to my discovery of OSS movement. The first one occurred when I began reading The Wealth of Networks[5] and the second one when I found about Connexions[6] . The former was a confirmation of my 10-year old discovery and the latter is what I am using to write this book. Connexions is a web-based curricular content authoring and publishing technology that I believe has a growing potential for writing and distributing free-of-charge learning materials.

Thus, motivation for this book stems from the notions that were generated by the OSS movement.

[1] This content is available online at <http://cnx.org/content/m41458/1.6/>.

[2] http://www.bcit.ca/

[3] *Just for Fun: The Story of an Accidental Revolutionary* by L. Torvalds and D. Diamond, New York: HarperCollins Publishers. ©2001

[4] *The Cathedral and the Bazaar* by E. S. Raymond, Sebastopol: O'Reilly Media. ©1999

[5] *The Wealth of Networks* by Y. Benkler, New Haven: Yale University Press. ©2006

[6] http://cnx.org/

The book was written to pay a small token of appreciation to BCIT and I hope it will be a contribution to the open educational resources repository.

Serhat Beyenir
North Vancouver, B. C.
25 October 2011

Study Guide[7]

MATLAB, a sub-course of Computer Technology 1 and this text are specifically designed for students with no programming experience. However, students are expected to be proficient in First Year Mathematics and Sciences and access to good reference books are highly recommended. I also assume that students have a working knowledge of the Mac OS X or Microsoft Windows operating systems.

The strategic goal of the course and book is to provide learners with an appreciation for the role computation plays in solving engineering problems. The MATLAB specific skills that I would like students to acquire are as follows:

- Write scripts to solve engineering problems including interpolation, numerical integration and regression analysis,
- Plot graphs to visualize, analyze and present numerical data,
- Publish reports.

The best way to learn about engineering computation is to actually do it. We will therefore solve many engineering problems mainly using a recent version of MATLAB in this book. Since the primary focus is engineering computation, we will concentrate on the mathematical solutions and, to a limited extent, the graphical user interface (GUI) features of MATLAB.

Learning a new skill, especially a computer program, can be an overwhelming experience. To make the best of this process, students are encouraged to observe the following guidelines that have proven to work well:

- Plan to study 2 hours outside of class for every hour inside of class,
- Practice, practice, practice: As the old saying goes, practice makes one perfect or perhaps we should modify that statement: Good practice makes one perfect,
- Buddy system: Study with a classmate. Helping one another drastically improves your understanding of the material. Particularly, students are advised to work the problem sets in this fashion,
- Muddy points: Make a note of muddy points as they may occur during lectures and email your notes to me. I will address those issues at the beginning of the next class,
- Open book exam: Do not try to memorize commands, functions or their syntax but learn where and how to find that information. Through many exercises and problem sets you will

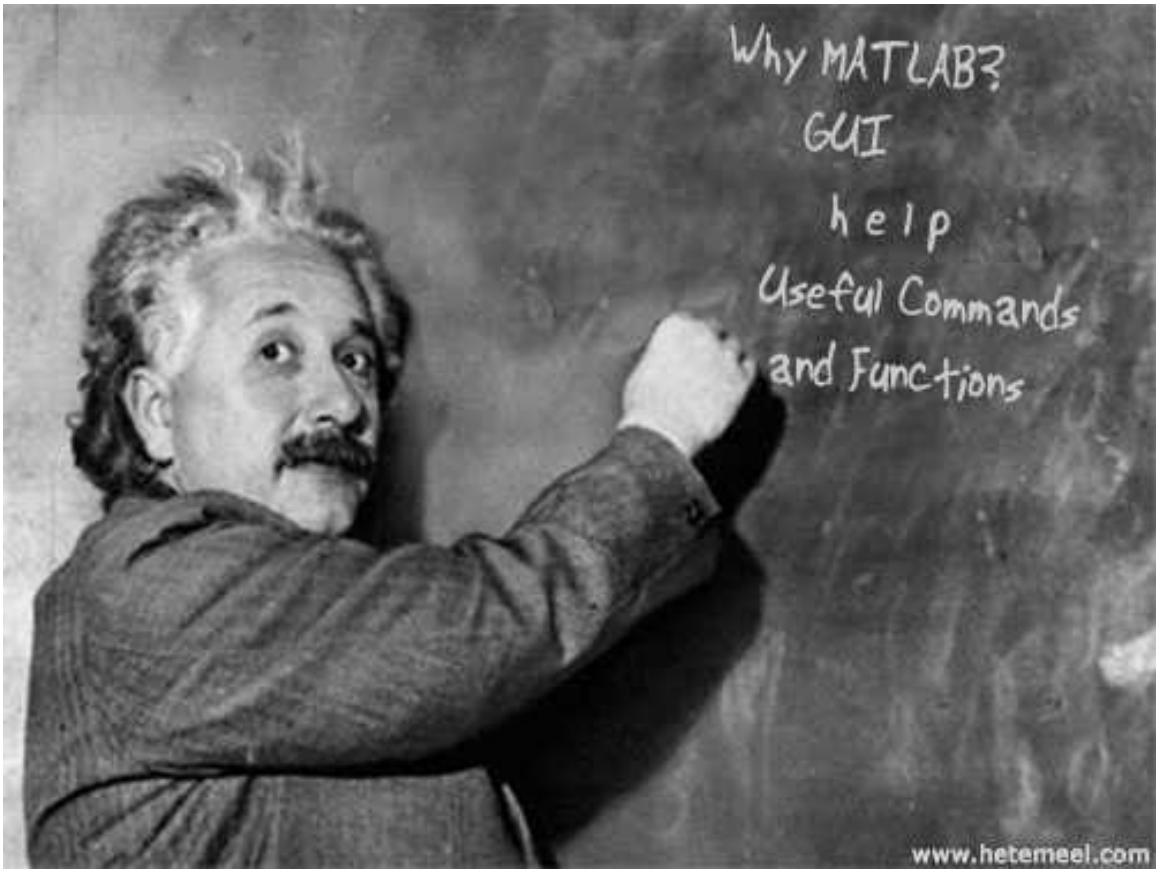
[7]This content is available online at <http://cnx.org/content/m41459/1.2/>.

have solved by the end of the course, most computational routines will become second nature to you. The exam is open book, so keep your learning materials and m-files well organized.

Chapter 1

Introduction

1.1 What is MATLAB?[1]



MATLAB stands for MATrix LABoratory (see wikipedia[2]) and is a commercial software application written by The MathWorks, Inc.[3] When you first use MATLAB, you can think of it as

[1]This content is available online at <http://cnx.org/content/m41403/1.2/>.

[2]http://en.wikipedia.org/wiki/MATLAB

[3]http://www.mathworks.com/

a glorified calculator allowing you to perform engineering calculations and plot data. However, MATLAB is more than an advanced scientific calculator, for example MATLAB's sophisticated numerical computation environment also allows us to analyze data, simulate engineering systems, document and share our code with others.

1.1.1 Why Use MATLAB?

MATLAB has become a defacto standard in many fields of engineering and science. Even a casual exploration of MATLAB should unveil its computational power however a closer look at MATLAB's graphics and data analysis tools as well as interaction with other applications and programing languages prove why MATLAB is a very strong application for technical computing.

The standard MATLAB installation includes graphics features to visualize engineering and scientific data in 2-D and 3-D plots. We can interactivity build graphs and generate MATLAB command output that can be saved for use in the future. The saved-instructions can be called again with different data set to build new plots. The plots created with MATLAB can be exported in various file formats (e.g. .jpg, .png) to embed in Microsoft Word documents or PowerPoint slideshows.

MATLAB also contains interactive tools to explore and analyze data. For example, we can visualize data with one of the many plotting routines, zoom in to plots to take measurements, perform statistical calculations, fit curves to data and evaluate the obtained expression for a desired value.

MATLAB interacts with other applications (e.g. Microsoft Excel) and can be called from C code, C++ or Fortran programming language.

1.1.2 Running MATLAB

To use MATLAB, it must be installed on your computer and you can start it just like you start any application on your system or you must have access to a network where it is available.

In POWR 3307, we will use MATLAB by accessing the BCIT network. The network access is platform independent, that is, we can run MATLAB under Mac OS X or Microsoft Windows operating systems through a web browser. The following links provide instructions on how to access and use BCIT's AppsAnywhere service:

How to access AppsAnywhere with Safari on a Macintosh Computer[4]

How to open and save files in AppsAnywhere when logging in from a Macintosh[5]

How to access AppsAnywhere using Firefox[6]

How to open and save files in AppsAnywhere when logging in from Windows[7]

[4] https://helpdesk.bcit.ca/fsr/sr/appsanywhere/750.html
[5] https://helpdesk.bcit.ca/fsr/sr/appsanywhere/807.html
[6] https://helpdesk.bcit.ca/fsr/sr/appsanywhere/701.html
[7] https://helpdesk.bcit.ca/fsr/sr/appsanywhere/806.html

A trial version of MATLAB can be obtained from the mathworks website.[8]

1.1.3 The MATLAB Desktop

When you start the MATLAB program, it displays the MATLAB desktop. The desktop is a set of tools (graphical user interfaces or GUIs) for managing files, variables, and applications associated with MATLAB. The first time you start MATLAB, the desktop appears with the default layout, as shown in the following illustration.

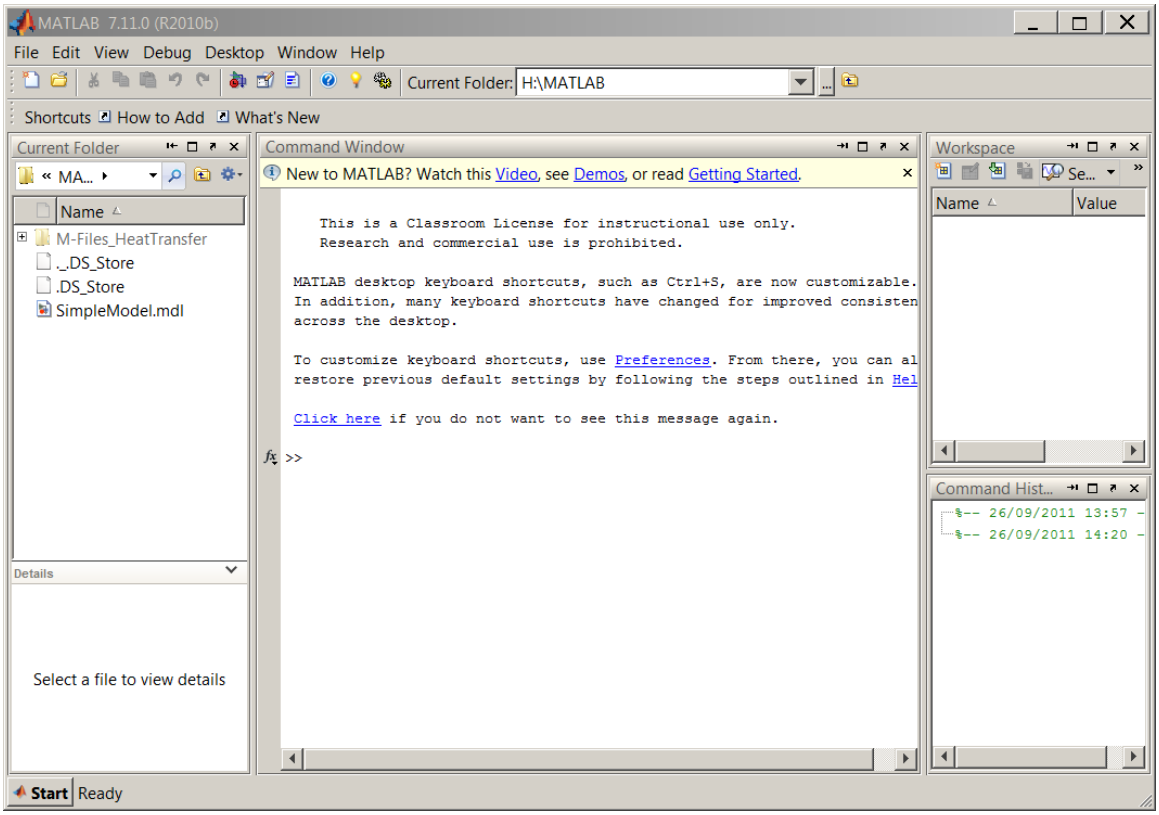


Figure 1.1: The MATLAB Desktop.

1.1.3.1 Command Window

The Command Window is where we execute MATLAB commands. We enter statements at the Command Window prompt. The prompt can be any one of the following:

[8] http://www.mathworks.com/products/matlab/tryit.html

- `Trial`≫ indicates that the Command Window is in normal mode and the MATLAB license will expire after the trial period ends.
- `EDU`≫ indicates that the Command Window is in normal mode, in MATLAB Student Version.
- ≫ indicates that the Command Window is in normal mode.

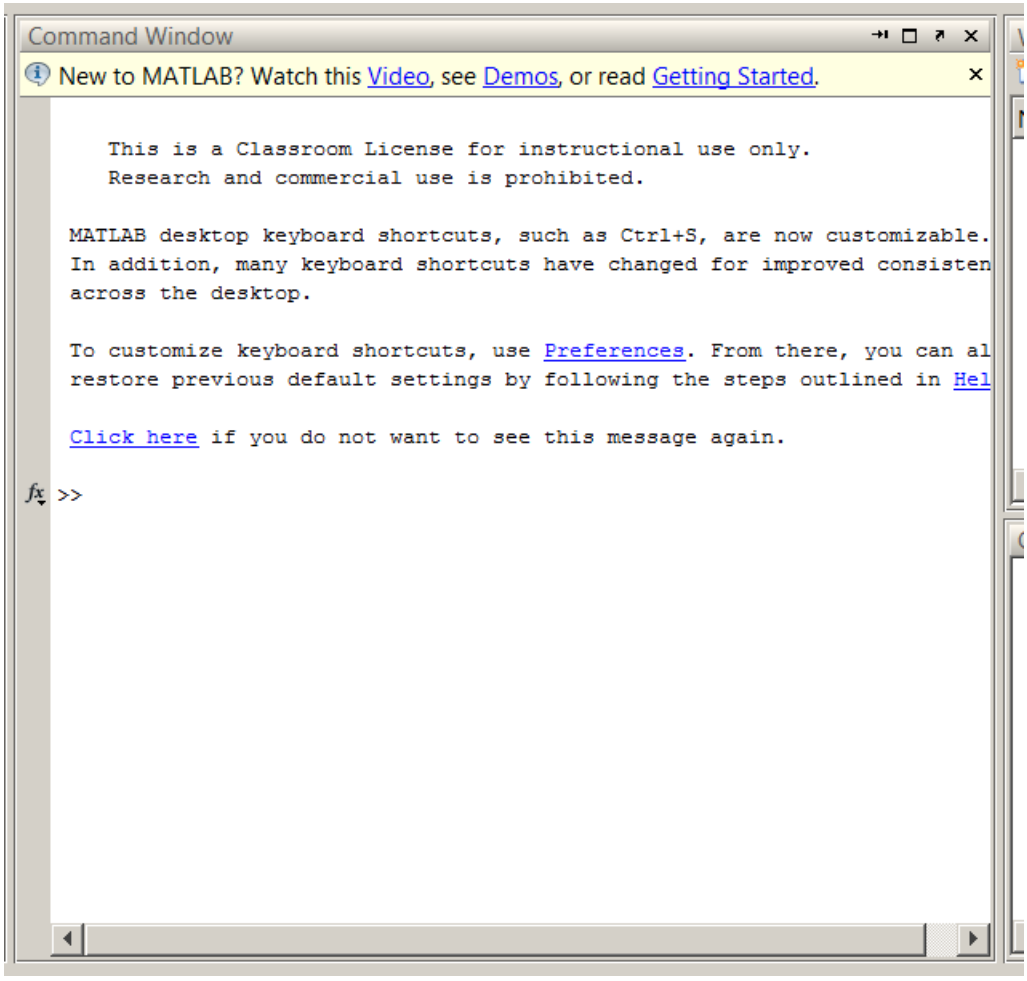


Figure 1.2: The Command Window.

1.1.3.2 Command History

The Command History is a log of the commands we have executed in the command window.

Figure 1.3: The Command History.

1.1.3.3 Workspace

The workspace consists of a set of variables stored in memory during a MATLAB session. To open the Workspace browser, select Desktop > Workspace in the MATLAB desktop, or type

```
≫ workspace
```

at the Command Window prompt.

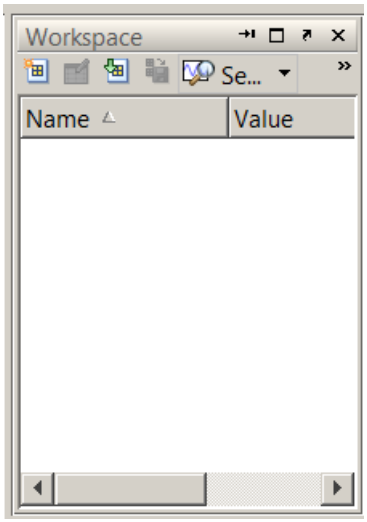


Figure 1.4: Workspace.

1.1.3.4 Current Folder

The Current Folder is like the Finder in Mac OS X or Windows Explorer in Windows operating systems and allows us to browse through the files and folders. The Current Folder also displays details about files in your current directory and within the hierarchy of the folders it contains.

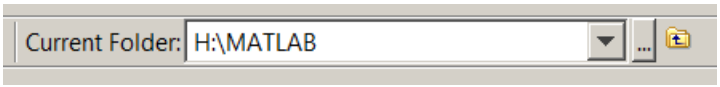


Figure 1.5: Current Folder.

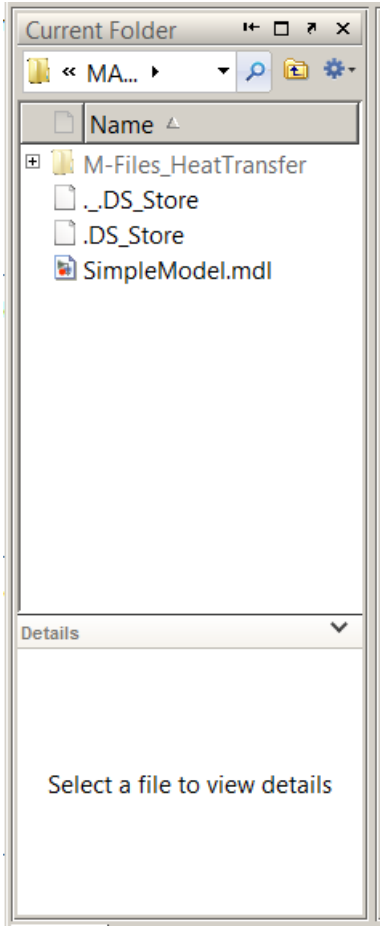


Figure 1.6: Current Folder docked on the desktop.

1.1.3.5 Start Button

The MATLAB Start button is located at the lower left corner of the MATLAB desktop and provides and easy access to tools, demos, and documentation for the MATLAB installation.

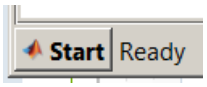


Figure 1.7: Start Button.

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