Introduction to MATLAB
ENGR 1187
MATLAB 1
Programming is a powerful tool for solving problems in every day industry settings. MATLAB is a program used for solving problems through numerical computation, plotting and logical programming. Devices such as robots are controlled by programs that act as a set of instructions for completing a task.
Today's Topics

- Introduction to the MATLAB interface
- Arithmetic Operations: Order of precedence
- Defining Variables
- Built-In Functions
- Script Files
- In Class Example
Today's Topics

- Introduction to the MATLAB interface
- Arithmetic Operations: Order of precedence
- Defining Variables
- Built-In Functions
- Script Files
- In Class Example
Opening MATLAB

- Open MATLAB now.

- CLICK on the shortcut icon → File
  - Alternatively, start/All programs/MATLAB

- The prompt “ >> “ should appear in the command window after initialization.
MATLAB Display

[1] Current Folder
[3] Command History
The Current Folder: MATLAB’s Working Directory

- Current folder is where files are saved and run from.

- When you first start MATLAB, it is a good practice to change the working directory to your Z: drive or USB device using the browse icon.
Today's Topics

- Introduction to the MATLAB interface
- Arithmetic Operations: Order of precedence
- Defining Variables
- Built-In Functions
- Script Files
- In Class Example
Arithmetic Operations: Order of Precedence

- Higher-precedence operations are executed before lower-precedence operations.
- Two operations having the same precedence are executed from left to right.

<table>
<thead>
<tr>
<th>PRECEDENCE</th>
<th>OPERATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Parentheses (innermost pair first)</td>
</tr>
<tr>
<td>Second</td>
<td>Exponentiation</td>
</tr>
<tr>
<td>Third</td>
<td>Multiplication and division</td>
</tr>
<tr>
<td>Fourth</td>
<td>Addition and subtraction</td>
</tr>
</tbody>
</table>
Arithmetic Operations: Order of Precedence

- Example: Find the average of two numbers: 7 and 8
  - \( \frac{7+8}{2} \) \( \frac{(7+8)}{2} \)

- Which command input is correct, A or B?
  - ans = 11  
  - ans = 7.5

- B is the correct input (ans = 7.5).
Arithmetic Operations: Order of Precedence

Example: Add the cube root of 27 to the 5th root of 32

- \[ \text{A: } 27^{1/3} + 32^{0.2} \]
- \[ \text{B: } 27^{(1/3)} + 32^{0.2} \]

Which command input is correct, A or B?

- \[ \text{ans = 11} \]
- \[ \text{ans = 5} \]

- **B** is the correct input (ans = 5).
Today's Topics

- Introduction to the MATLAB interface
- Arithmetic Operations: Order of precedence
- Defining Variables
- Built-In Functions
- Script Files
- In Class Example
Defining Variables

- In MATLAB we can assign data to variables so they can be stored in memory.

- For example, enter the following in the command window & hit enter:
  - `>> x = 5`

- Now look at your work space
Defining Variables

- Now this variable can be used in arithmetic operations.

- For example, enter the following in the command window & hit enter:
  - >> x + 5  (you should get 10!)

- Now say we want to add 15 to x and make x the new value.
  - This is reassigning the variable x.
  - >> x = x + 15
  - Now check your workspace, what’s the value of x?
Rules in Naming Variables

- Variable names cannot exceed 63 characters
- Names **must** begin with a **letter**
- May contain **letters, digits, and the underscore character**
  - **No spaces are allowed**
- MATLAB **is** case sensitive
- Avoid naming variables with currently defined MATLAB functions
  - **Ex:** `exp`, `sin`, `cos`, `sqrt`, `length`, `mean`, `max`, `min` etc.
Variable Name Examples

- **Allowed**
  - My\_name
  - MyName
  - Myname32

- **Not allowed**
  - 1Name (starts with numeral)
  - My Name (no spaces allowed)
  - My-Name (no special characters allowed)
Calculations with multiple variables

- Define the following two variables:
  - `>> var1 = 5`  `>> var2 = 20`

- Now we can use these two variables to perform arithmetic operations and create a new variable in the process.
  - `>> var3 = var2/var1`
  - (you should get 4!)

- Now check your workspace and you should see these variables.
Today's Topics

- Introduction to the MATLAB interface
- Arithmetic Operations: Order of precedence
- Defining Variables
- Built-In Functions
- Script Files
- In Class Example
Built-In Functions

- Examples of Pre-defined in MATLAB
  - `exp(x)` – exponential \( e^x \)
  - `log(x)` – natural logarithm \( \log_e(x) \)
  - `log10(x)` – base 10 logarithm \( \log_{10}(x) \)
  - `sqrt(x)` – square root \( \sqrt{x} \)
  - `abs(x)` – absolute value \( |x| \)

- For trigonometric functions, \( x \) is entered in radians
  - `sin(x)`, `cos(x)`, `asin(x)`, `acos(x)`, `tan(x)`, `cot(x)`

- To enter \( x \) in degrees...
  - `sind(x)` where \( x \) is in degrees
Built-In Functions

- Example: Calculate the sine of $\frac{\pi}{2}$
  - Good news, MATLAB defines $\pi$.
    - $\gg \text{pi}$
    - ans = 3.1416

- Solution
  - $\gg \sin(\text{pi}/2)$
  - ans = 1
Built-In Functions

- Let’s combine what we have learned so far:
  - Example 1: Calculate $\sin(2x)$ where $x = \pi/4$

- Solution
  - $\gg x = \text{pi}/4$
  - $\gg \sin(2\ast x)$
  - $\text{ans} = 1$
Built-In Functions

Let’s combine what we have learned so far:

- Example 2: Calculate \( y = \frac{(\cos 2x)(\sin^2 x) + \tan \left( \frac{x}{2} \right)}{e^{3x}} \), where \( x = 30^\circ \)

  NOTE: \( x \) should be in radians, not degrees.

- Solution:
  
  \[
  \begin{align*}
  \gg x &= 30^\circ \times \frac{\pi}{180} \\
  \gg y &= \frac{(\cos(2x))(\sin(x)^2) + \tan(x/2)}{e^{3x}} \\
  y &= 0.0817
  \end{align*}
  \]
Command Window Functions

- To clear the command window, use “clc”
- To clear all variables defined in our workspace, use “clear”
Today's Topics

- Introduction to the MATLAB interface
- Arithmetic Operations: Order of precedence
- Defining Variables
- Built-In Functions
- Script Files
- In Class Example
Script Files

- A MATLAB script file (.m extension) is a program file created by you the user that executes a series of MATLAB commands (i.e., basic arithmetic).

- A new script file can be opened by selecting the new script icon under the Home tab.
Script Files

- Script files should be saved periodically as you are programming.
- In this class save to your Z-drive or a USB drive.
  - Remember, wherever you save your file should be the same as the working directory you are working in.
  - SAVE YOUR WORK AS YOU GO!
Saving a Script File

- The name of the script file is governed by the following rules:
  - No spaces are allowed
  - The name cannot start with a numeric
  - No special characters are allowed (except underscore)

**Allowed:**
- Prob1a.m
- Prob_1a.m

**Not Allowed:**
- Prob 1a.m (blank space)
- 1aProb.m (can’t start with numeric)
- Prob-1a.m (no special characters)
Useful Commands in Script Files

- To suppress command window output, use a semicolon after the statement ";"
  - For example: x = 5;

- To send a text message to the command window or display contents of a variable, use “disp(...)”
  - Example 1: disp('Hello World')
    - Note: The text in this command is referred to as a string. Strings must have single quotes at both ends of the string.
  - Example 2: disp(x)
    - Displays the values stored in x
Script File Header

- All homework and in class activities done must include a header as shown below. Example is provided on the course website.

```
% Script Header
% This script is for course ENGR 1107
% MATLAB 01 - Intro to MATLAB

% Clear workspace memory
clear

% Clear command window
clc

% Display first and last name
disp('Last Name, First Name')

% Display course information
disp('ENS 1107, Seat #')

% Display Assignment title
disp('Assignment Name')

% Add some space
disp('')
```

NOTE: NO TEXT GOES PAST THE VERTICAL LINE
Today's Topics

- Introduction to the MATLAB interface
- Arithmetic Operations: Order of precedence
- Defining Variables
- Built-In Functions
- Script Files
- In Class Example
In Class Example

- Let’s create a script file that calculates hypotenuse of triangle based on Pythagoras theorem.

- Pythagoras theorem: $a^2 + b^2 = c^2$
In Class Example

- Steps for creating script (similar to homework format)
  1. Create a script file and name it Pyth.m
  2. Create script file header (programmer info)
  3. Create the body of the program
     a) Assign the height of the triangle to a variable
     b) Assign the base of triangle to a variable
     c) Compute the hypotenuse of the triangle
In Class Example

Solution

```matlab
% Clear the workspace memory
clear
% Clear the command window
clc
% Display first and last name
disp('Last Name, First Name')
% Display course information
disp('ENG 1187, Seat ##')
% Display Assignment title
disp('Assignment Name')
% Add some space
disp('')

% Compute the hypotenuse of a triangle

% Assign the height
h = 3;

% Assign the base
b = 4;

% Compute hypotenuse
hyp = sqrt(h^2 + b^2);

% Display the output
disp(hyp)
```
Publishing you work

- When submitting your work use the publishing tool in MATLAB to create a PDF of your work.
  - Select:
    - Publish tab
    - Publish Drop Down Menu
    - Edit Publishing Options...
Publishing you work

- In the Edit Configurations window under Output Settings:
  - Select the box to the right of **Output file format**
    - Select PDF and close.
Publishing your work

- Not select the publish button and MATLAB will run your script file and create a PDF of your script file and the output
Preview of Next Class

- Array Creation
  - Difference between scalars and vectors
  - How to create a row/column vector in MATLAB
  - Examples of how to set constant spacing in vectors
  - Special commands and matrix examples
What’s Next?

- Submit the in-class activity to today’s dropbox.
- Review today’s Quiz #01.
- Start working on MAT-01 homework.
- Prepare for next class by reading about array creation in MATLAB - array creation is a useful way to store data to be analyzed or plotted.