LAB 1

Fundamental Concepts

Objective

The aim of this introductory lab is to introduce you to the basic functions in the Matlab and Numerical Methods with Matlab toolbox. By the end of today's lab, you should be able to understand the Matlab windows, working with basic commands, Elementary built in functions, Variable declaration and Rules for variables

Submission Requirements

You are expected to complete the assigned tasks within the lab session and show them to the lab engineer/instructor. Some of these tasks are for practice purposes only while others (marked as '*Exercise'* or '*Question*') have to be answered in the form of a lab report that you need to prepare. Following guidelines will be helpful to you in carrying out the tasks and preparing the lab report.

Guidelines

- In the exercises, you have to put the output in your Lab report. You may add screen print to the report by using the 'Print Screen' command on your keyboard to get a snapshot of the displayed output. This point will become clear to you once you actually carry out the assigned tasks**.**

- Name your reports using the following convention:
  ### *Lab#_Rank_YourFullName*
  - o '#' replaces the lab number
  - o '*Rank'* replaces Maj/Capt/TC/NC/PC
  - o '*YourFullName*' replaces your complete name.
- You need to submit the report even if you have demonstrated the exercises to the lab engineer/instructor or shown them the lab report during the lab session.

MATLAB is stand for MATrix LABoratory. It is a mathematical package based on matrices and consists of extensive library of numerical routines.

- All Data stored in the form of a matrix
- Case-sensitive
- The basic data type is matrix (normally with 16 decimals precision)
- Possible to handle complex numbers
- High-Level programming language and Matrix based computing environment
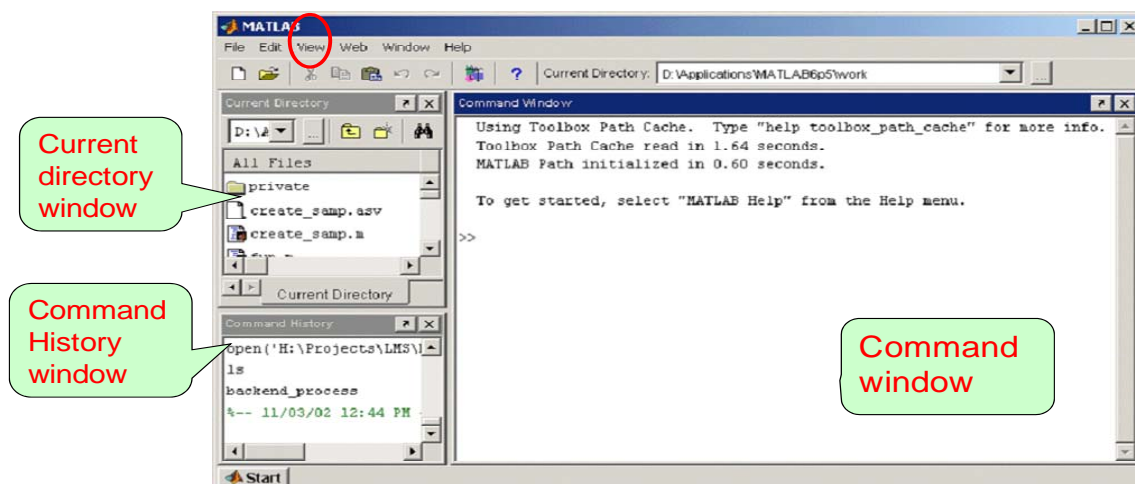- Visualization of data as advanced graphics two and three dimensional

How to run MATLAB

From Start Menu   -> Select Programs ->Select MATLAB 7.1
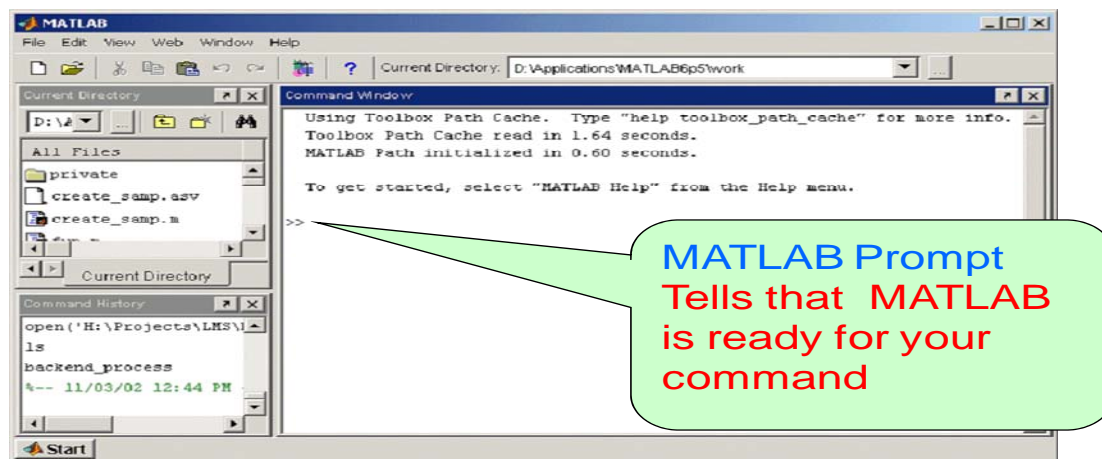
## MATLAB Layout

Different windows can be selected to appear (View)

Note:- The above window can be displayed by first selection Desktop Layout from View menu

Matlab Windows

Windows	Purpose
Command Window	Main windows enters variable, runs programs
Figure Window	Contains output from graphic commands
Editor Window	Create and debugs script and function files
Help Window	Provides help information
Command History Window	Logs commands entered in the command window
Workspace Window	Provides information about the variables that are used.
Current Directory Window	Shows the file in the current directory

Working with command window

- Type command in the front of command prompt (>>)
- Press **Enter key,** the command is executed.
- Several commands can be typed in the same line by separating by comma.
- Previously typed command can be recalled by **up-arrow key** and **down-arrow** key can be used to move down the previously typed commands.
- If the command is too long to fit in one line, it can be continued to the next line by typing three dots ... (called an ellipsis)
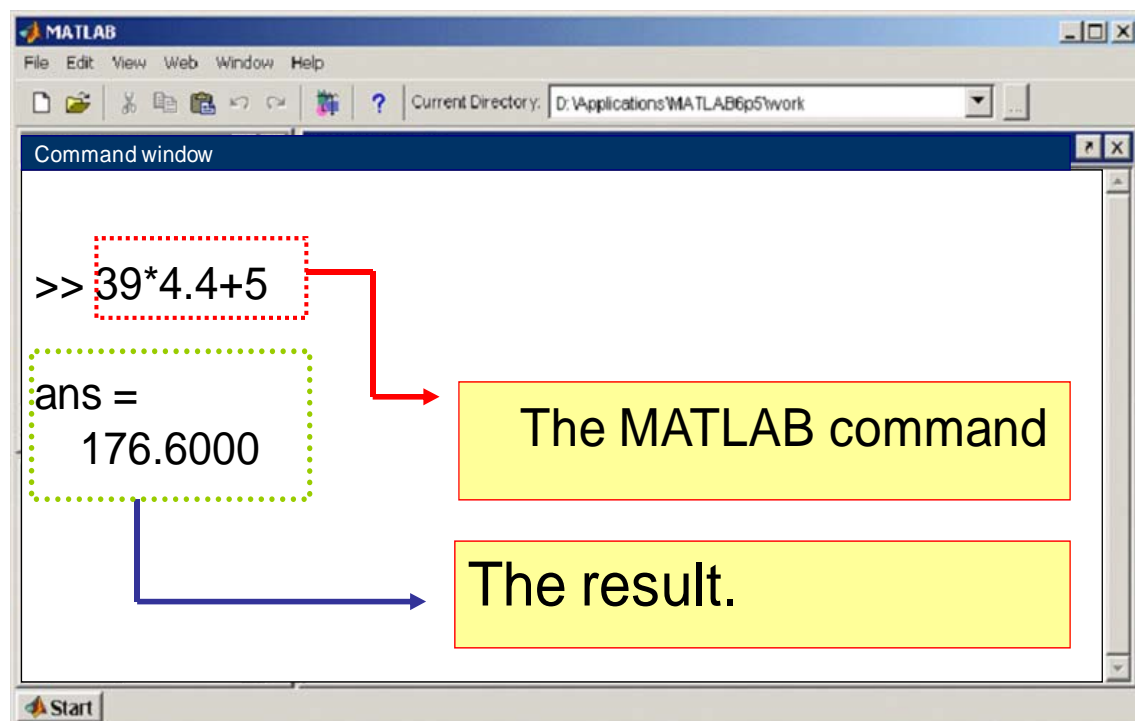
The Semicolon (;)

When command is executed the very next will display the output of the command. If a semicolon is typed at the end of command the output is not displayed (called suppress the output).

Typing % or %{ and }%

When the symbol % (percent symbol) is type in the beginning of a line, the line is designated as a comment, which is called single line comments.

When any number of statements written between symbols %{ and %} is treated comments, which is called multi-line comments or blocks commenting.

Workspace	All variables used in the current MATLAB session are saved in the Workspace and Save in .mat file
clc	The *clc* command clears the command window and does not change anything that was that was done before
clear	Remove all variable from the current workspace/memory.
clear x y z	Removes only variable x, y and z from current workspace/memory.
who	Display a list of the variables in the current workspace/memory.
whos	Display a list of the variables in the current workspace/memory and their size together with information about their bytes and class.
what	Show all M-files in the current directory (Z:\)
pwd	Show current working directory path (z:\)

Arithmetic Operation with scalars

Operation	Symbol	Example
Addition	+	5+3
Subtraction	-	5-3
Multiplication	*	5*3
Right division	/	5/3
Left division	\	5\3 or 3/5
Exponentiation	^	5^3

Order of Precedence

In an expression that has several operation, higher precedence operation are executed before lower precedence operations. Following order of precedence will be followed in matlab

Operation	Mathematical Operation
First	Parentheses.
Second	Exponentiation
Third	Multiplication, Division
Forth	Addition and Subtraction

Practice 1

```
>> 7+8/2                              %8/2 is executed first
ans =    11


>> (7+8)/2
ans =   7.5000                        %7+8 is executed first


>> 4+5/3+2                            %5/3 is executed first
ans =   7.6667


>> 5^3/2                             %5^3 is executed first, /2 is executed next.
ans =   62.5000


>> 27^1/3+32^0.2                      %1/3 is executed first, 27^num second
ans =    11


>> 0.7854-(0.7854)^3/(1*2*3)+0.785^5/(1*2*3*4*5)...
-(0.785)^7/(1*2*3*4*5*6*7)           %Continuation of line


ans =    0.7071
```

Display Formats

Short is the default format in matlab, which is fixed point with 4 decimal digits. The format can be change with the format command. Several of the available formats are described bellow

Command	**Description**	**Example**
format short	Fixed point with 4 decimal digits	>> 290/7 Ans=41.4286
format long	Fixed point with 14 decimal digits	>> 290/7 Ans=41.42857142857143
format short e	Scientific notation with 4 decimal digits	>> 290/7 Ans=4.1429e+001
Format long e	Scientific notation with 15 decimal digits	>> 290/7 Ans=4.142857142857143
Format short g	Best of 5 digits fixed or floating point	>> 290/7 Ans=41.429
Format long g	Best of 15 digits fixed or floating point	>> 290/7 Ans=41.4285714285714
Format bank	Two decimal digits	>> 290/7 Ans=41.43

Math Built in Functions

- Matlab has very large library of built in functions.
- A function has a name and an argument in parenthesis

When a function is used the argument can be a number, a variable that has been assigned a numerical value or a computable express that can be made up of number or variables.

Practice 2

```
>> sqrt(64)                          %Argument is a number
ans =    8

>> sqrt(-64)                         %Argument is a –tive  number
Ans =   0 + 8.0000i

>> sqrt(50+14*3)                     %Argument is an expression
ans =  9.5917

>> sqrt(54+9*sqrt(100))              %Argument includes a function
ans =   12

>> (15+600/4)/sqrt(121)             %Function is included in an expression
ans =   15
```

Following is the list of commonly used Matlab built-in functions

Elementary math functions

Function	Description	Example
sqrt(x)	Square root	>> sqrt(81) Ans=9
exp(x)	Exponential (e^x)	>> exp(5) Ans=148.4132
abs(x)	Absolute value	>> abs(-24) Ans=24
log(x)	Natural logarithm. Base e logarithm(ln)	>> log(1000) Ans=6.9078
log10(x)	Base 10 logarithm	>> log10(1000) Ans=3.0000
factorial(x)	The factorial function x! (x must be a positive integer)	>> factorial(5) Ans=120

Trigonometric math functions

Y in degrees = X in radians *(pi/180)

Function	Description	Example
sin(x)	Sine of angle x (x in radians) x=30	>> sin(pi/6) Ans=0.5000
cos(x)	Cosine of angle x (x in radians) x=30	>> cos(pi/6) Ans=0.8660
tan(x)	Tangent of angle x (x in radians) x=30	>> tan(pi/6) Ans=0.5774
cot(x)	Cotangent of angle x (x in radians) x=30	>> cot(pi/6) Ans=1.7321

Rounding functions

Function	Description	Example
round(x)	Round to the nearest integer	>> round(17/5) Ans=3
fix(x)	Round towards zero	>> exp(13/5) Ans=2
ceil(x)	Round towards infinity	>> ceil(11/5) Ans=3
floor(x)	Round towards minus infinity	>> floor(-9/4) Ans=-3
rem(x)	Returns the remainder after x is divided by y.	>> rem(13,5) Ans=3
sign(x)	Sign function. Returns 1 if x>0, -1 if x<0 and 0 if x=0	>> sign(5) Ans=1

Scalar Variables and assignment in Matlab

A variable is a name of a letter or a combination of server letters that is assigned a numerical value. Once variable is assigned a numerical value, it can be used in mathematical expressions, functions etc. In Matlab the = sign is called assignment operator. The assignment operation assigns a value to a variable.

Variable_name=A numerical value, or a computable expression

- 1×1-matrices are called scalars
- No declaration of variables (matrix is the key-word). These are defined by assignment.
- Assignments are done by = ended by Enter.

Rules for variable name
- Name can be upto 63 character long
- Can contain letters, digits and the underscore character
- Must begin with letter
- Avoid using the name of built-in function for a variable. Once a function name is used to define a variable, the function can not be used.

Practice 3

```
>>A = 7.5*2                %Computed result stored in A
A=15

>>7.5*2                    %Computed result stored in ans, which is default variable
ans=15

>>x = 15                   %The number 15 is assigned to the variable x.
x=15

>>x = 3*x-12               %A new value is assigned to x
x=33

>> a=12                    %Assign 12 to a
a = 12

>> B=4                     %Assign 4 to B
B =  4

>> C=(a-B)+40-a/B*10       %Assign the value of the expression to the variable C
C = 18

>> a=12, B=4; C=(a-B)+40-a/B*10      %The Variable B is not displayed
A=12
C = 18

>> ABB=72;                 %A value of 72 is assigned to the variable ABB

>> ABB=9;                  %A new value of 9 is assigned to the variable ABB

>>ABB                      %Show the current value in variable
ABB=9

>>x=0.75;                  %Once a variable is defined it can be used as an argument
>>E=sin(x)^2+cos(x)^2
E=1
```

Predefined Variables

A number of frequently used variable are already defined when Matlab is started. Some are listed here.

Ans   A variable that has the value of the last expression that was not assigned to a specific variable.

pi   The numer π (3.1416)

eps   The smallest difference between two number Equal to 2^{-52}, which is appx 2.2204e-016

inf   Used for infinity

i   Defined as $(-1)^{1/2}$, which is 0+1.0000i

j   Same as i.

NaN   Stands for Not a Number. Used when Matlab cannot determine a valid numeric value. (0/0)

Practice 4:   Trigonometric identity

A trigonometric identity is given by

$$\cos^2(x/2)=(\tan x +\sin x)/2\tan x$$

Variable that the identity is correct by calculating each side of the equation, substituting $x=\pi/5$

>> x=pi/5;

>> LHS=cos(x/2)^2
LHS = 0.9045

>> RHS=(tan(x)+sin(x))/(2*tan(x))
RHS = 0.9045

For Section A

Exercise 1:   Classic Quadratic Formula

The classic quadratic formula says that the two root of the quadratic equation
$$ax^2 + bx + c = 0$$
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

use this formula in Matlab to compute both roots for a=1,b=-100000000, c=1 compare your results with

>>roots([a,b,c])

Exercise 2:

Flowers are packed in boxes such that a dozen are placed in each box. Determine how many boxes are needed to pack 751 flowers, using the ceil function.

For Section B

Exercise 1:

A triangle sides are a=18cm,b=35cm, and c=50cm. Define a, b, and c as variables, and then calculate the angle γ (in degree) by substituting the variable in the Law of cosines. (The Law of Cosines: $c^2 = a^2+b^2 - 2abcos\ \gamma$).

Exercise 2:

The distance d from a point (x_0, y_0) to a line Ax+By+C=0 is given by:
$$d = \frac{|Ax + By + C|}{\sqrt{A^2 + B^2}}$$

Determine the distance of the point (2,-3) from the line 3x+5y-6=0. First define the variables A, B, C, x_0, and y_0 and then calculate d. (Use the abs and sqrt functions)

Exercise 3:

Basket Balls are packed in containers such that a six are placed in each container. Determine how many containers are needed to pack 551 Balls, using the ceil function.