# National Aviation University

Aerospace Faculty

«Researching interface of the MATLAB, working with numbers and arrays, plotting 1d functions»

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Kiev 2019

# **Laboratory Work #1**

Researching interface of the MATLAB, working with numbers and arrays, plotting 1d functions

This Laboratory Work, as well as another ones, is an approximate plan only how to learn the theme entitled. Students are encouraged to investigate the theme and to experiment with MATLAB as wide as they can. And sometimes you make an unexpected discovery indeed **☺** … Your main task with it is to gather first MATLAB skills and master its plotting tools.

1. Run MATLAB: how does its interface look like? How could you configure it? What "windows" may it have? For what purpose are used the *Command Window* and *Command History Window*? What about other windows? How to configure your working environment to be the most comfortable?

We need the following windows for comfortable work: Workspace, Command Window(main window for mathematic operations in MATLAB), Command History Window(it shows any operations and commands that were done).

Other windows can be opened situationally, like Plots Window if we run *plot* or *ezlpot*.

We can call other windows with the Layout Menu.

The most comfortable is the following configuration: Command Window, Workspace, Command History

1. MATLAB Help: how to find it, how to ask for it? For instance, get help for *fplot* or for *ezplot.*

Help can be found on main panel or can be called using F1 key. For getting help use command *help fplot* or *help ezplot.*

1. Explain the MATLAB operations +, -, \*, /, ^, *sqrt* (try to ask >> *help arith*). Explain intrinsic functions like *sin*, *cos, tan*, *exp, log, log10*. Try to calculate for example  with ***і*** (a complex number!) and ? What to try other values of  and ? How does MATLAB complain about input errors? Try any other calculations with real and complex numbers, for instance (*a*) *sin*(47o), *cos*(80o)? (*b*) *sin*(**i**), *cos*(***i***), *tg*(***i***), *exp*(***i***), *log*(***-1***)? Why you were told in the school that  or  do not exist? How do you understand “*the complex number*”?

+ Plus.

X + Y adds matrices X and Y.

- Minus.

X - Y subtracts matrix X from Y.

\* Matrix multiplication.

X\*Y is the matrix product of X and Y.

^ Matrix power.

Z = X^y is X to the y power if y is a scalar and X is square. If y is an

integer greater than one, the power is computed by repeated

multiplication. For other values of y the calculation

involves eigenvalues and eigenvectors.

Z = x^Y is x to the Y power, if Y is a square matrix and x is a scalar,

computed using eigenvalues and eigenvectors.

Z = X^Y, where both X and Y are matrices, is an error.

|  |  |  |  |
| --- | --- | --- | --- |
| sin | Sine of the input | sin(*u*) | [sin](https://www.mathworks.com/help/matlab/ref/sin.html) |
| cos | Cosine of the input | cos(*u*) | [cos](https://www.mathworks.com/help/matlab/ref/double.cos.html) |
| tan | Tangent of the input |  |  |
| exp  log | [Y](https://www.mathworks.com/help/matlab/ref/exp.html#bt9_gkt-1-Y) = exp([X](https://www.mathworks.com/help/matlab/ref/exp.html#bt9_gkt-1-X)) returns the exponential ex for each element in array X.  For complex elements *z* = *x* + *iy*, it returns the complex exponential  log(b, x) represents the logarithm of x to the base b. |  |  |
| Log10 | Common logarithm (base 10) |  |  |

*((sqrt(x) + sqrt(y))/(sqrt(x) - sqrt(y))) + ((sqrt(x) - sqrt(y))/(sqrt(x) + sqrt(y)))*

*ans =*

*-0.7692 - 1.8462i*

Lets try other values of x and y:

*x=5*

*y =8*

*>> ((sqrt(x) + sqrt(y))/(sqrt(x) - sqrt(y))) + ((sqrt(x) - sqrt(y))/(sqrt(x) + sqrt(y)))*

*ans =-8.6667*

*sind(45)+cosd(80)*

*ans = 0.8808*

*sin(i)*

*ans = 0.0000 + 1.1752i*

*cos(i)*

*ans =1.5431*

*tan(i)*

*ans =0.0000 + 0.7616i*

*exp(i)*

*ans =0.5403 + 0.8415i*

*log(-1)*

*ans = 0.0000 + 3.1416i*

A complex number is a number that can be calculated from expression a+b\*i, where i=sqrt(-1)

1. Try to calculate , , to plot and compare results with built-in functions *sinh* and *asinh*. Your conclusion? What about *cosh* and its inverse?

(Some details might be found in <http://en.wikipedia.org/wiki/Hyperbolic_trig_functions#Standard_algebraic_expressions>)

*X=1*

*Y=2*

*F1=1/2\*(exp(x)-exp(-x))*

*F1 =1.1752*

*F2=log(x+sqrt(x^2+1))*

*F2 =0.8814*

*sinh(F1)*

*ans =1.4650*

*sinh(F2)*

*ans =1*

*asinh(F1)*

*ans =1*

*asinh(F2)*

*ans = 0.7950*

1. What of the *descriptors* (*identifiers*) are allowed in MATLAB? Which are not? Could you explain the role of descriptors *ans*; *pi*, *i*, *j*, *inf*, *NaN* ? Explain the role of operators **=** and **;** (semicolon)**.**

In MATLAB are allowed following descriptors: (A–Z, a–z, 0–9) and underscores, not allowed descriptors that begin with a symbols. ans – result of calculating, pi – 3.14, i = complex bumber(sqrt(-1)), j – imaginary unit. inf - infinity, NaN - values that are not real or complex numbers , which stands for “Not a Number”.

= - equal

; - The semicolon can be used to construct arrays, supress output from a MATLAB command, or to separate commands entered on the same line.

1. How to input arrays of dimensions *m* x *n*? Examples: 1) ; 2) row-matrix ; 3) column matrix . Explain operations over matrixes (+, -, \*, **.**\* , /, **.**/ , ^, **.**^). What may be reasons for MATLAB to "complain"?
2. A=[1 2 3; 2,1 3,3 4,25; 5,7 0,03 -1,7]
3. r = [2,1 3,3 4,25]
4. c=[2; 3,3; 3exp-2]

If a=[m; n], a+x or a-x will be add or substract x to each element of matrix.

\* - matrix multiply

.\* - multiply the corresponding elements of two matrices or vectors

/ - matrix division

./ - division the corresponding elements

^ - power each element

.^ - power corresponding elements

1. Imagine you have an array *M* with a huge number of columns. How to get an array *M*1 that includes only each 3rd column of *M*? For the matrix *A* given, extract a sub-matrix of a fewer dimension from it. How to transpose matrix? How to get the length and size of an unknown matrix?

M1=(:,3)

B = squeeze(A) use for extract sub matrix B with 1 dimension less.

B = A' use for transpose matrix A

length(A)' use for get length(number of columns) of matrix A, size(A) use for get size(rows).

1. How to get "regular" arrays like  or ? Operator **:** (colon). What could you tell about its use?

The colon is used to create vectors, arrays and specify for iterations.

To create an array with four elements in a single row, separate the elements with either a comma ( , ) or a space. This type of array is a row vector.

1. Discover the accuracy of MATLAB's calculations. How could be controlled the significant digits of MATLAB 's output? Try the commands *format short* or *format long* in the Command Window, or other formats via menu ***File\Preferences…***

*>>format short*

*>> pi*

*ans =3.1416*

*>> format long*

*>> pi*

*ans =3.141592653589793*

For longer output of significant digits use *format long*, for short use *format short*

1. Find Help about plotting graphics in MATLAB. What commands for plotting graphics does it have? Plot the simplest graphics like ,  etc with the coefficients , , ,  of your own.

*a = 2*

*b = 5*

*k1=3*

*k2=6*

*d=2*

*y=asin(k1\*x)+cos(k2\*x)*

*y =2.530966613445263 - 1.762747174039086i*

1. Plot several graphics in the same window; plot another graphics in a new window. Explain the commands *figure*(1), *figure*(3), etc as well as *hold on* and *hold off*. Investigate the commands *plo*t, *fplot*, *ezplot* and *comet*.

Examples of parametric graphics: (***1***) *ezplot*('t\*cos(t)','t\*sin(t)',[0,8\*pi],2);

(***2***) *ezplot*('sin(3\*t)\*cos(t)','sin(3\*t)\*sin(t)',[0,pi])

Please do the same with the command *plot*. What is the difference?

1. *a*) Plot the "*first remarkable curve*"\*)  for several  in the same graph. What was told about its behavior at  in the Higher Mathematics course? *b*) Validate by means of plotting that the numerical sequence  converges for  and find approximately the limiting value (the so called "*second remarkable limit*"\*)). Note that  is discrete and positive in the last case!
2. How may the MATLAB′ commands *grid,* *xlabel*, *ylabel, title, axis, legend* "decorate" your plots?. How to apply various curve styles and colors while plotting graphs? How to include plotted graphics in your Word documents?

Grid - display or hide axes grid lines

xlabel - labels the x-axis of the current axes or chart returned by the gca command

ylabel - labels the y-axis of the current axes or chart returned by the gca command. Reissuing the ylabel command causes the new label to replace the old label.

Title(‘Sample text’) – shows a title of your plot

plot(x,y,'color letter') – colors your plot

color letters:

b blue

g green

r red

c cyan

m magenta

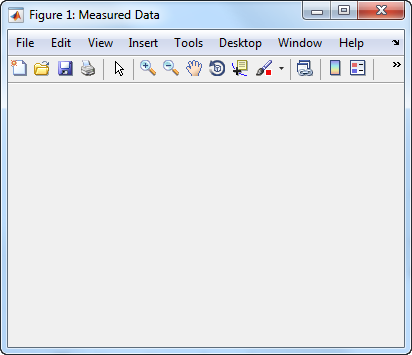
y yellow

k black

w white

Export["filename.png", yourgraph] – exports your plot for using in Word documents.

1. Investigate the graphical window "Figure": what menus and icons does it have, how could you evoke "Property Editor" and change attributes of you plots?



15.1.[[1]](#footnote-1) Validate by plotting that the below Taylor series\*):

 converges to the function .

(One could inquire in <http://en.wikipedia.org/wiki/Taylor_series>).

15.2. Validate by plotting that the below Taylor series\*):

 converges to the function .

15.3. Validate by plotting that the below Taylor series\*):

 converges to the function  (See *No*. 4.).

15.4. Validate by means of plotting that the below Fourier series\*)

, 

converges to the function . Could you plot the ? What is the  on the whole line ?

(Explanations might be found in <http://en.wikipedia.org/wiki/Fourier_series>)

16. Learn "*Text arrays*" like . Strictly follow to the rule that number of characters in each column element have to be equal! Suggest examples of *text arrays* of your own. Do they need in Programming?

Conclusion: MATLAB has many functions that allow us calculate almost everything using relevant commands. MATLAB also can work with complex and irrational numbers, build plots and creating arrays, matrixes etc.

For comfortable and useful work with MATLAB we should know commands and syntax,

**Use the above hints in your own works, as well as in your Laboratory Work Report *No.* 1.**

**Some hints how to execute the laboratory work and to write its report may be found in:**

1. **Гаєв Є.О., Нестеренко Б.М.** Універсальний математичний пакет MatLab і типові задачі обчислювальної математики. Навчальний посібник.– К.: НАУ, 2004. – 176 с. (may be taken in NAU library).

2. **GayevYe.A., Nesterenko B.N.** MATLAB for Math and Programming. Textbook. Запоріжжя: Поліграф. – 2006.– 102 p. <http://sula.nau.edu.ua/ukr/person/gaev/books/gayev_matlab.pdf>

3. **Азарсков В.М., Гаєв Є.О.** Сучасне програмування, частина 1. К.: 2014.– 254 с.

4. **Гаєв Є.О., Азарсков В.М.** Сучасне програмування, частина 2. К.: 2017.– 196 с.

1. Your variant number *VarN*, either 15.1 or 15.2, 15.3 or 15.4 may be determined by MATLAB calculation *VarN*=*mod*(*N\_list*,4)+1 where *N\_list* is your numbers in class list. [↑](#footnote-ref-1)