

# MATH 22AL

## Lab # 1

### Introduction:

#### 1 It is assumed that

1. You already have your user name and password
2. You know how to login to the Department of Mathematics computers (point, round or line) in a terminal window in room 2118, or using your own computer and
3. You know how to start MATLAB .

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If you need help on login please click here [Login](#).

This introductory lab provides a brief tutorial on MATLAB. Please follow the instructions carefully: type each command exactly as given, then press **Enter** (or **Return**) to execute it.

Additional background information is available at [A Few Notes on MATLAB](#). You are encouraged to review this resource as you work through the lab.

### A Few Notes on MATLAB

In this course, we use the computer not only to implement algorithms and models, but also as a powerful tool for exploring mathematical concepts, forming conjectures, and discovering patterns that lead to meaningful results.

MATLAB is an interactive computing environment designed for efficient numerical computation, particularly with matrices and vectors, which makes it especially well suited for linear algebra.

To perform symbolic computations in MATLAB, an additional toolbox is required. The **Symbolic Math Toolbox**, which is based on the computational engine of *Maple*, allows you to carry out symbolic manipulation such as exact algebraic simplification, differentiation, and equation solving directly within MATLAB.

**The Following information/instructions are needed for the entire quarter.**

**1.1 Everything you do must be done on terminal window on the Math Dept servers.**

**Do not use MATLAB downloaded on your computer, DO NOT use online MATLAB.**

- 1 Matlab is case sensitive; for example, a and A represent different objects.
- 2 You type commands at the MATLAB prompt: >>.
- 3 Do not copy–paste. Doing so may introduce invisible characters that cause errors in MATLAB and during grading.
- 4 Do not change the names of variables.
- 5 If MATLAB returns ans = ..., this is fine; do not replace ans with something else.
- 6 Do not obtain answers from ChatGPT. During grading, this may produce errors and you may end up visiting SJA.
- 7 You will work in two environments: (i) MATLAB interactive session, (ii) Pico text file.
- 8 MATLAB interactive session: you type commands and MATLAB responds; no editing is possible.
- 9 Pico text file: you can edit, but no interaction with MATLAB is possible.
- 10 Understand the difference between save and diary off.
- 11 Your lab should start with diary LAB... and end with diary off.

- 1.
- 2.
3. If you type

**TO START: Open a terminal window and Login to one of Math Department computers (tangent or point, round), and follow the instruction below.**

## 2 Objectives

In this LAB you will explore the following topics using MATLAB.

- Basic MATLAB command
- Access or redefine any sub-matrix of a given matrix
- Constructing large matrices using small matrices.
- Creating vectors with equi-spaced elements
- Commands for elementary row operations

## Starting MATLAB and Recording your work

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The following steps will help you start and record your work and save and submit it successfully.

- **Open a terminal window.**
  - In Computer LAB (1118 MSB) click on terminal Icon at the bottom (or left side) of the screen
  - In Windows OS, Use windows terminal
  - In MAC OS, Use terminal window of MAC.
- **Start a MATLAB Session** that is :
  - After opening a terminal window and login,

**type**      `textmatlab`                      then press return or enter to start a MATLAB Session

- It may take about 10 seconds or more for MATLAB to start.
  - You should see MATLAB command line prompt: `>>`
- **Ask MATLAB to save what you are typing in a file called LAB1.text** as follow :

**type**      `diary LAB1.text`                      then press return or enter to continue your work.  
 diary LAB1.text command asks MATLAB to open a file named LAB1.text and copy whatever you type in this session on that file.

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This will open a file in the background called LAB1.text and copy what ever you type here in that file.

## Entering your information

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```
type % First Name:      Example: % Jennifer
type % Last Name:       Example: % Brown
type % Username:        m22als4-25.
type % today's Date:    as mm/dd/yyyy
```

## Ways to enter a vector in MATLAB: Direct; Using Command

You must press enter or return each time after typing the command

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```
type u = [4 1.5 3.9]      to create a 3-element row vector 3-element .
type v = [1 2 3.1 5]';    as creates a 4-element column vector.
                           Prime will create the transpose.
```

In entering a large vector that does not fit in one line, before going to the next line type 3 dots like ... then, continue entering the rest of the vector in the next line.

```
type v1 = [1; 2; 3.1; 5]  to create the same column vector using semicolons.
```

```
type w = [2 2.6 5 1 ...   Make sure to press enter,
                           Matlab will wait for your to enter the rest of the vector
type 11.6 9 -8]           this is the rest of the vector.
type t = [u v']           Using brackets to combine two vectors.
```

Noticed that we used  $v'$ , because  $v$  is a column vector, where  $u$  is a row vector.

```
type s= [ u' v ]          this will produce an error.
                           because the size of the vectors does not match.
```

## Ways to enter Matrices in MATLAB

You must press enter or return each time after typing the command

### 6

**type**    `A = [1 2 3 ; 3 4 5 ; 4 5 6]`    This will create a 3 by 3 matrix.  
You need a space between the numbers in each the row entries and  
a semicolon between the rows.

**type**    `A1 = [11 12 33 ; 5 14 35]`    This will create a 2 by 3 matrix.  
we have two rows separated by a semicolon.

**type**    `B = eye(4)`    to create a 4 by 4 identity matrix.

**type**    `C = rand(4)`    to create a 4 by 4 matrix with  
randomly generated entries distributed uniformly between 0 and 1.

**type**    `D= rand(4,3)`    to get a 4 by 3 random matrix.

**type**    `who`    to see a list of your variables.

**type**    `clear D`    to clear the variable D.

**type**    `who`    you will not see D in the list.

**type**    `D=rand(5)`    to create a 5 by 5 random matrix.

**type**    `D=10*D`    to multiply every entry of D by 10.

**type**    `D=round(D)`    to round the entries of D to be integers.  
Now you have a random matrix with integer entries.

You can do all three operation with a single command :

**type**    `D=round (10*rand(5))`    to get a random matrix with integer entries.

**type**    `E= magic(3)`    to get a 3 by 3 magic matrix. Why it is called magic?  
Explain by typing % then enter your comment.

**type**    `E= magic(4)`    to get a 4 by 4 magic matrix. Why it is called magic?  
Explain. % then enter your comment.

## Working with entries, rows, and columns of a matrix:

You must press enter or return each time after typing the command. If a question asked, please type % then enter your answer.

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type	<code>A(2,2:3)=[3,4]</code>	To change the entries (2,2) and (2,3) to 3 and 4 respectively.
type	<code>A</code>	To Access the matrix A.
type	<code>A23=A(2,3)</code>	To Access the entry (2,3) of A .
type	<code>row2=A(2,:)</code>	To Access the entire second row of A. In <code>A(2,:)</code> the symbol colon ":" in second component means select entries from all columns.
type	<code>col3=A(:, 3)</code>	To Access the entire third column of A. The symbol ":" means select entries from all rows of A.
type	<code>subD1=D(2:3, 1:3)</code>	To Access the sub-matrix of D consisting of the entries on the second-third row and on the first through third columns.
type	<code>subD2=D([1 3], 1:3)</code>	to see the sub-matrix of D consisting of the entries on the first and third row and on the first through third columns.
type	<code>subD3=D(1:2:5, 1:3)</code>	Note that <code>1:2:5</code> selects the the first, increments by 2 and then selects 3, increments by 2, selects 5.
type	<code>subD4=D([1 3 5], 1:3)</code>	This should give you the same submatrix obtained by the previous command <code>subD3=D(1:2:5, 1:3)</code> .

Now type the following and explain on your own word what happened for all 3 following commands (By typing on a new line to percentage sign % followed by your comments you may avoid receiving an error message).

type	<code>A(2,3) = -2</code>	to replace the (2, 3) entry by -2.
type	<code>A(2,:) = [0 1 0]</code>	to replace the entries in the second row by 0, 1, 0
type	<code>A(3,2:3) = [3 4]</code>	Explain what this command is performing.

## Creating matrix extracting parts of a matrix :

For this part : You must press enter or return each time after typing the command. If a question asked, please type % then enter your answer.

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Sometimes you want Matlab to do computation but not to show the answer on the screen. In this case to avoid a display, put a semicolon ";" at the end of the line. See the following example:

```
type  B=[ 6 4; 3 0];  To create another matrix called B, but not display it
type  B               To see the matrix B
```

### Working with diagonal matrices:

```
type  diag(A)         to see a vector of diagonal entries of A
type  diag(ans)       to see a matrix of zeroes with the same diagonal entries
                        as A
type  diag(diag(A))   to see a matrix of zeroes with the same diagonal entries
                        as A.
```

### Creating zero matrices and matrices of ones:

```
type  ones(3)         to create a matrix of entries 1.
type  zeros(4)        to create a 4X4 matrix of entries 0.
type  zeros(3, 4)     to create a 3X4 matrix of entries 0.
type  ones(3,4)       to create a 3X4 matrix of entries 1.
```

Use commands, diag, ones, eye, to construct a 4 by 4 matrix of ones , with 2, 3, 4, and 5 on the main diagonal. note that you can Add matrices of the same size.

```
type  diag([ 1 2 3 4])  To create a matrix with diagonal 1, 2, 3, 4
type  ones( ? ) + diag([ 1 2 3 4])  You need to decide what number to put for "?".
```

### Multiplying a matrix A by a constant k

```
type  AA= ones(4)      To create a 4X4 matrix with entries 1
type  AA4 = 5*AA       To create a 4X4 matrix with entries 5
type  AA3= 3*AA        To create a 4X4 matrix with entries 3
```

**Exercise:** Construct a 4 by 4 matrix of 7s , with 5, 5, 5, and 5 on the main diagonal. That is all none diagonal entries are 7 and diagonal entires are 5

## Constructing large matrices using small matrices.

For this part : You must press enter or return each time after typing the command. If a question asked, please type % then enter your answer.

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<code>type</code>	<code>row1=[ 2 2 2 ]</code>	to create a 1 by 3 matrix ( row vector).
<code>type</code>	<code>col1=row1'</code>	to create the transpose of r , a 3 by 1 matrix ( column vector).
<code>type</code>	<code>A=[1 2 3; 3 4 5; 4 5 6]</code>	to see the matrix A
<code>type</code>	<code>A'</code>	to see the transpose of the matrix A
<code>type</code>	<code>M=[A ; row1]</code>	to add a new row to A to create a 4 by 3 matrix. Note that the number of the columns A and the vector <i>row1</i> must be the same.
<code>type</code>	<code>N=[A col1]</code>	to add a new column to A to create a 3 by 4 matrix. Note that A and the vector <i>col1</i> must be the same number of the number of the rows .
<code>type</code>	<code>B1=[A N]</code>	to create a 3 by 7 matrix. Note the space between two matrices.
<code>type</code>	<code>B2=[A ; M]</code>	to create a 7 by 3 matrix.
<code>type</code>	<code>B3=[A ;N]</code>	Why are you getting an error message?
<code>type</code>	<code>B4=[A M]</code>	Why are you getting an error message?



## Creating vectors with equispaced (evenly spaced) elements

For this part : You must press enter or return each time after typing the command. If a question asked, please type % then enter your answer.

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```
type    a=[ 1 3 5 7]    to create a vector with equispaced elements, in which
                        neighboring elements are separated from each other by a
                        fixed amount (the step size).
type    a1 = 1:2:7      to create the vector a1= [ 1 3 5 7] , above. Step size is
                        two=2.
type    a2 = 1:1:7      to create the vector a2= [ 1 2 4 3 5 6 7] , above. Step
                        size is one=1.
type    a3 = 1:7        to create the vector a3= [ 1 2 4 3 5 6 7] , above. Step
                        size is one=1.
type    b = 3:7         to produces the vector with integer elements : 3, 4, 5, 6
                        and 7. Step size is one.

type    c = 13:2:25     To obtain odd integers between, 13 and 25
                        The step-size (the separation between the values of neigh-
                        boring elements) must be put between two colon opera-
                        tion.
```

### How to Create Evenly Spaced Vectors:

```
type    c1 = 1:4        To Create a vector from 1 to 4, spaced by 1, we used the
                        colon operator (:).
type    c2 = 1:0.5:4    To Create a vector from 1 to 4, spaced by 0.5.
type    c3 = linspace(1,10,7) To Create a vector with 7 elements. The values are evenly
                        spaced from 1 to 10.
type    c4 = linspace(1,10,5) To Create a vector with 5 elements. The values are evenly
                        spaced from 1 to 10.
```

**Example:** In the following example 15 is the first element the others obtained by adding 4 each time the last element must be smaller than or equal to the third number.

```
type    c = 15:4:35
type    c = 15:4:36
type    c = 15:4:37
type    c = 15:4:38
type    c = 15:4:39
type    c = 15:4:40
```

The syntax for the colon operator is **x = start value: step : Stop value**  
Both Integer values and decimal numbers can be used.

You can Create the vector [2 5 8 11] using the following commands:

```
type    x= 2:3:11
type    x=linspace(2, 11, 4)
```

## Creating vectors with equispaced elements

For this part : You must press enter or return each time after typing the command. If a question asked, please type % then enter your answer.

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The syntax for the colon operator is `x = start value: step : Stop value`  
Both Integer values and decimal numbers can be used.

```
type    x = 0.2:0.25:1    to created [0.2 0.45 0.7 0.95]
```

If the start and stop values and number of the elements are known we can use the function `linspace`.

```
type    x = linspace(1.2, 2, 5)    will create a 5-element vector with start value of 1.2 and
                                         stop value of 2 that is
                                         x =[ 1.2000 1.4000 1.6000 1.8000 2.0000]
```

**Interpolation** is about calculating a function's value based on the value of other data-points in a given sequence. This function may be represented as  $f(x) = \sin(x)$ , and the known  $x$  values may range from  $x_0$  to  $x_n$ .

The following is the general form of the command if you type this, you will get an error, Why? ( No need to enter it in MATLAB)

```
v= linspace(start,stop,nv)
```

```
type    x = 0:0.5:6
type    y = sin(x)
```

to plot the function you can type the following:

```
type    xi = linspace(min(x),max(x),100);
type    yi = spline(x,y,xi);
type    plot(x,y,'o',xi,yi)
```

You may not see the graph if you are working on your laptop. You will see it if you work at a terminal in the computer room. If you have MATLAB on your laptop you can type the past 5 commands in your MATLAB to see the graph.

Sample commands for elementary row operations Let N be the 3 by 4 matrix that you built in the last step. Suppose first you want to interchange the rows 2 and 3.

```
type    TEMP= N(2,:)    to store the second row of N as TEMP.
type    N(2,:) =N(3,:)    to replace the second row of N by the third row of N.
type    N(3,:) =TEMP    to replace the third row of N by TEMP which was the
                           second row of N .
```

Now suppose that you want to multiply the second row of the new matrix N by 5 .

```
type    N(2,:)=5*N(2,:)    to multiply the second row of N by 5
```

Now suppose that you want to add -7 times the second row to the third row.

```
type    N(3,:)= -7*N(2,:)+N(3,:)    to add a multiple of the second row to the third row.
```

## Array Operations

For this part : You must press enter or return each time after typing the command. If a question asked, please type % then enter your answer.

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Array Operations: Type the following commands and for each of them explain what the command is performing.

<b>type</b>	<code>E1= [1 2; 3 4] + 1</code>	Explain what is going on.
<b>type</b>	<code>E2= 5*[1 2; 3 4] + 1</code>	Explain what is going on.
<b>type</b>	<code>m1= [1 1; 1 1]*[2 2; 2 2]</code>	This is normal matrix multiplication you will learn soon in your linear algebra class.
<b>type</b>	<code>m1= [1 1; 1 1].*[2 2; 2 2]</code>	the dot before the * perform element-wise multiplication.
<b>type</b>	<code>S2= [ 1 2 3 4; 0 9 8 2; 0 6 7 3]</code>	to create a 3 by 4 matrix called S2
<b>type</b>	<code>size(S2)</code>	to access the size of matrix S2
<b>type</b>	<code>AZ=[1 2 104;3 4 2;47 20 99;5 55 3]</code>	to create a 5by 3 matrix AZ
<b>type</b>	<code>[xmax,idx]=max(AZ(:,1))</code>	to access the maximum value in the first column of AZ and its index.
<b>type</b>	<code>[xmax,idx]=max(AZ(:,2))</code>	to access the maximum value in the second column of AZ and its index.
<b>type</b>	<code>[xmax,idx]=max(AZ)</code>	to access the maximum value in each column of AZ and their index.

## Finishing your LAB and submit it

Note : The File name must be **LAB1.text** otherwise it will not be graded

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**type**      save            to save your variables for future use  
**type**      diary off      to stop copying in the file " LAB1.text and saving and  
                                  closing it.  
**type**      exit            to exit MATLAB

Use a local editor (pico) to edit your diary file (LAB1.text), you must delete all the errors you made. DO NOT delete the errors asked and created by the LAB to point out something.

If you are using one of the terminals in the computer room first you need to type ssh point as follow.

**type**      ssh point                      to connect to one of the computers in Math Dept.  
**type**      submitm22al LAB1.text      to ssubmit your LAB to math22al TA

You will see on the computer screen saying: Sending LAB1.text to 22al TA.....  
 Take a screenshot of it or a picture for your Records.