BRAC UNIVERSITY
CSE 330: Numerical Methods (LAB)
Lab 2: Arrays, Matrices and Graphics

Arrays
Arrays are one/two dimensional sequence of numbers. A one dimensional array is often called a vector.

Vectors can be of two types: Row Vector and Column Vector.

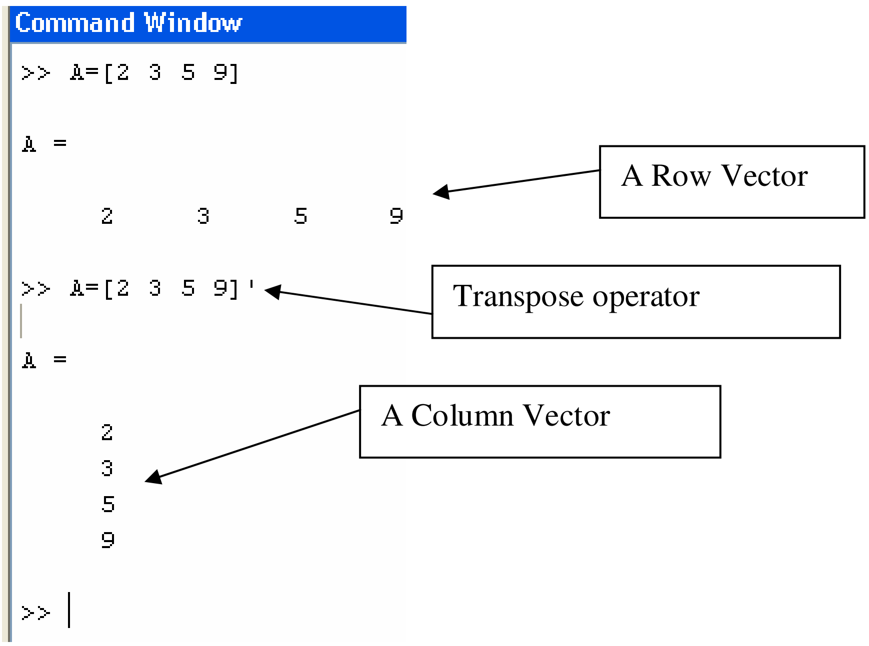


Figure 1: Defining Row and Column Vectors in MATLAB

The Colon operator
A convenient MATLAB syntax exists to declare vectors of arbitrary size and resolution.

The syntax is:

V= Start Value : Increment : End Value ;

Where V is the vector name.

In Figure 2 it is demonstrated how to use this syntax to generate vectors of desired length and resolution.

Command Window

```
>> vect= 3:2:9

vect =

     3     5     7     9

>> v= -1:0.4:1

v =

   -1.0000   -0.6000   -0.2000    0.2000    0.6000    1.0000

>> E= 100:-10:40

E =

   100    90    80    70    60    50    40

>> theta=-pi:(pi/5):pi

theta =

  Columns 1 through 9

   -3.1416   -2.5133   -1.8850   -1.2566   -0.6283         0    0.6283    1.2566    1.8850

  Columns 10 through 11

    2.5133    3.1416
```

Here start value is -1 increment is 0.4 and end value is 1

Here values are decremented

Figure 2: Defining Row and Column Vectors using the "colon" operator

Matrix

A Matrix is a two dimensional array.

Study Figure 3 to learn how to define a Matrix of any size. Here a 3 x 3 Matrix has been defined. It is possible to access individual elements as well as any particular row or column.

Two often used functions are **ones( )** and **zeros ( ).** Study Figure 4 to identify their purpose.

The length function returns the 'row size' for a Row Vector and 'column size' for a column vector. For Matrix, **length** ( ) returns the maximum of the row and column numbers.
Size ( ) returns the number of Rows and number of Columns of a Matrix.

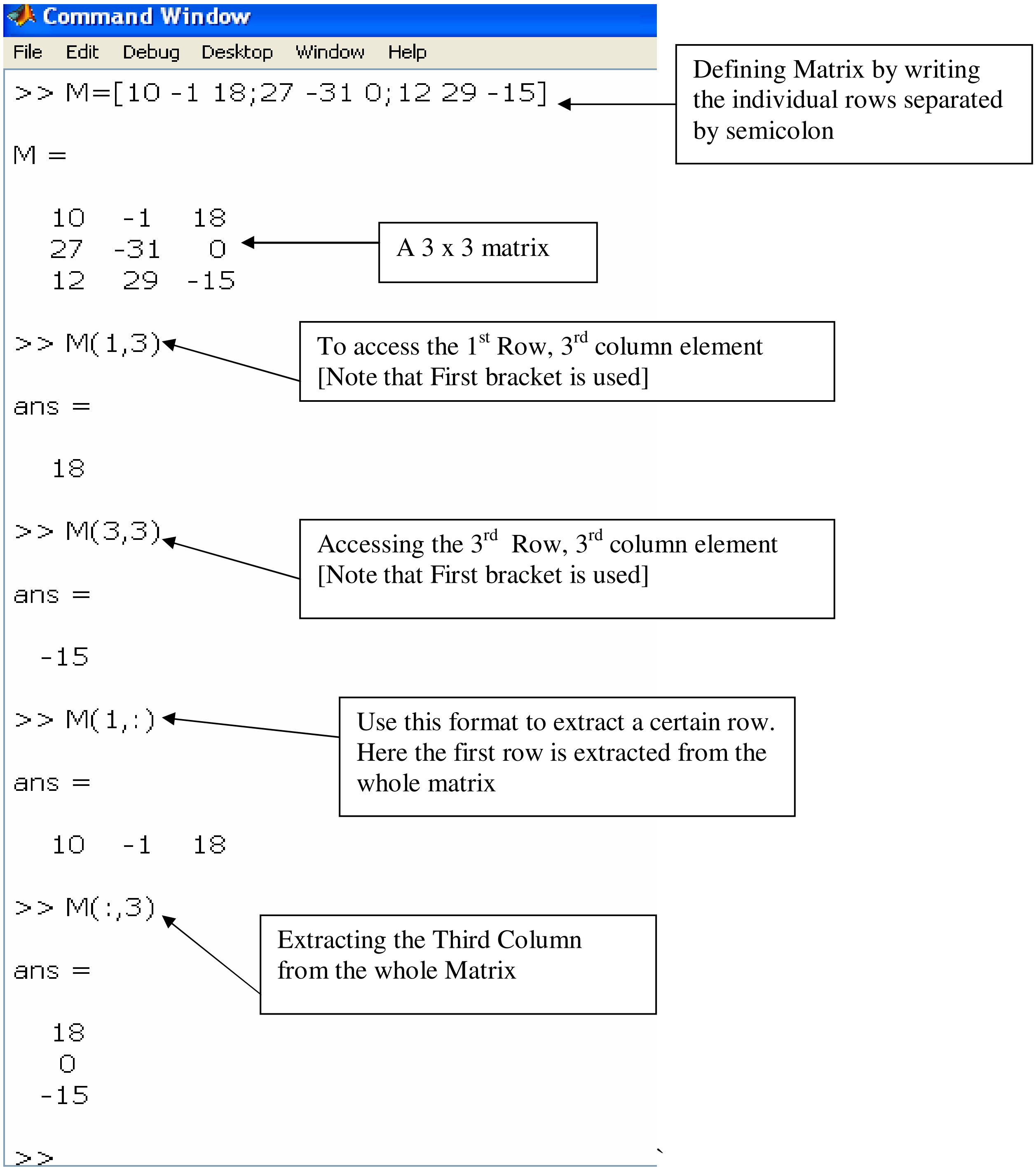
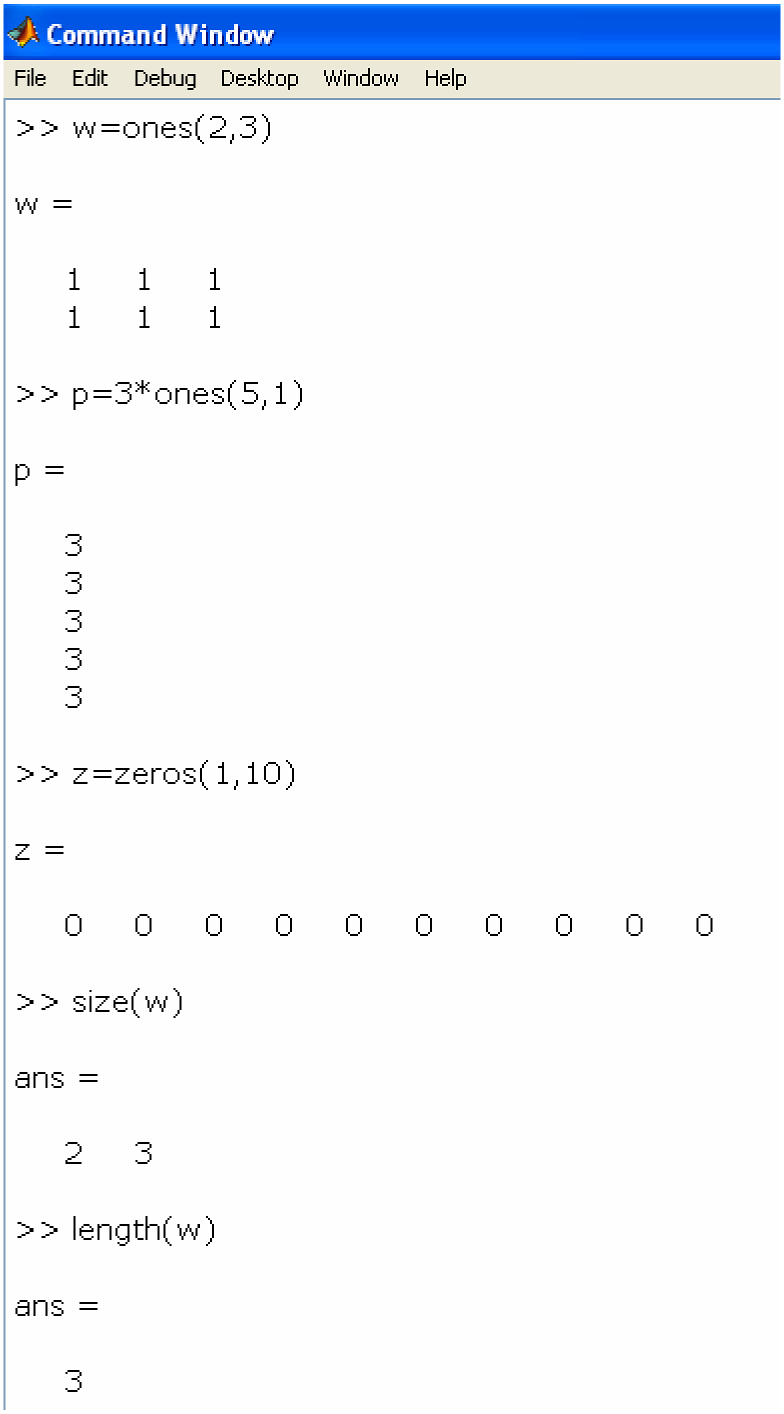


Figure 3: Defining Matrix and Accessing Individual elements, rows and columns.




```
>> w=ones(2,3)

w =

     1     1     1
     1     1     1

>> p=3*ones(5,1)

p =

     3
     3
     3
     3
     3

>> z=zeros(1,10)

z =

     0     0     0     0     0     0     0     0     0     0

>> size(w)

ans =

     2     3

>> length(w)

ans =

     3
```

Figure 4: Ones, Zeros, length and size functions

```
Command Window
>> X=[2:1:4;5:1:7;8:1:10]

X =

     2     3     4
     5     6     7
     8     9    10

>> Y=X'

Y =

     2     5     8
     3     6     9
     4     7    10

>>
```

Using Transpose operator

Y is Transpose of X

Figure 5: Matrix Transposition

Matrix Arithmetic

To add, subtract the matrices must be of same size.
Matrix multiplication can be of two types: Normal matrix multiplication and element wise multiplication. To perform the normal matrix multiplication for loop statement is required. For element wise multiplication the two matrices must be of same size and the "DOT" operator must be used.
Study Figure 6 to learn the use of the "dot" operator.

Lab Task 01:

Let $A = \begin{bmatrix} 1 & 2 & 5 \\ -3 & 2 & 0 \\ 12 & 1 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} -2 & 0 & -7 \\ 13 & 2 & 0 \\ 2 & 1 & 3 \end{bmatrix}$

Write a M File to perform the following:

- Perform A + B
- Perform A .*B [Element wise multiplication]

```
>> x=[2 8 10];
>> y=[1 2 3];
>> z=x./y

z =

   2.0000    4.0000    3.3333

>> r=x./2

r =

     1     4     5

>> M=[1:2:5;-3:2:1;2:2:6]

M =

     1     3     5
    -3    -1     1
     2     4     6

>> pow=M.^2

pow =

     1     9    25
     9     1     1
     4    16    36

>> |
```

The DOT operator is used to perform element wise operation on the vector/matrix elements

Each Element is raised to Power of two

Figure 6: The use of DOT operator

Graphics

Get familiar with the following key graphics functions. [Take the aid of Help menu]

Key functions: plot( ), xlabel( ), ylabel( ), title( ), stem( ), subplot( ). grid on, hold;

Suppose the following data need to be plotted

X	**Y**
1	0
1.5	0.41
2	.7
2.5	.91
3	1.1
3.5	1.3
4	1.38
4.5	1.51
5	1.61
5.5	1.7
6	1.8
6.5	1.87
7	1.95
7.5	2.01
8	2.1

Study how to plot the above data from Figure 7

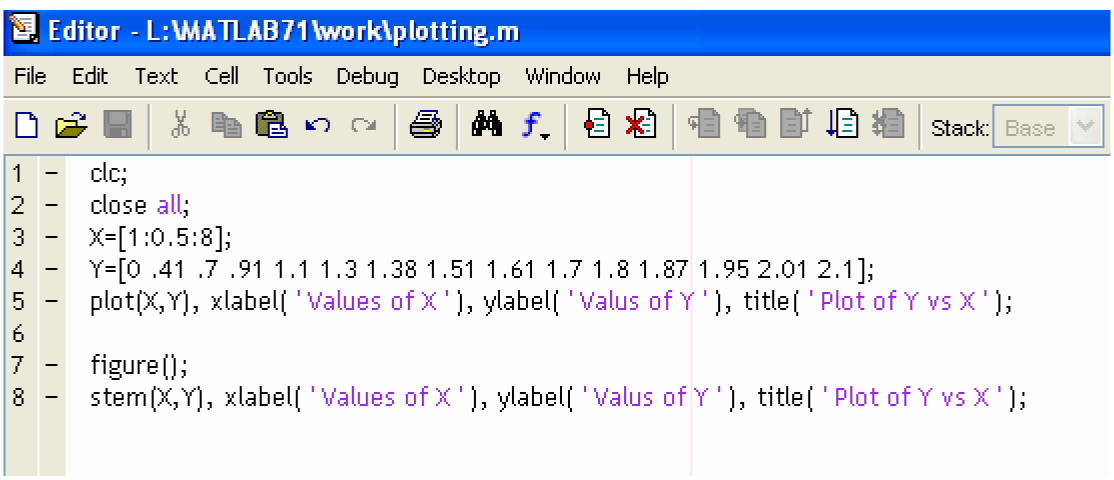


Figure 7: Plotting from given data.

Plotting Sine wave

To plot sine function or any other function like **exp ( )** or **log( ),** first you will need to generate values of the function at desired values of the independent variable.

Suppose you wish to plot the curve, y = Sin [100πt] . So frequency is 50 Hz. And time period is 0.02 sec. If you wish to plot three cycles then the final time must be 0.06 sec. So the independent variable, t, is varied from 0 to 0.06 sec. The more the number of data samples the better will be the plot shape. So step size should be small. Study Figure 8 .

Editor - L:\MATLAB71\work\sinplot.m

```
clc;
close all;
freq=50;          % defining frequency as 50 Hz
per=1/freq;       % Finding the time period

t1=0 : ( per / 5 ) : 0.06     % The valus of time axis is selected. Note that Three Periods are included
y1=sin( 2 * pi * freq * t );

figure(1);
subplot(211),plot(t1,y1), xlabel( ' Time in seconds ' ), ylabel ( ' y1=sin100*pi*t' )
subplot(212),stem(t1,y1), xlabel( ' Time in seconds ' ), ylabel ( ' y1=sin100*pi*t' )


t2=0 : (per/20) : 0.06              % [Comment line] Note that the sampling rate is increased here
y2=sin(2*pi*freq*t2);               % Higher sampling rate improves the waveshpe

figure(2);

subplot(211),plot(t2,y2), ,xlabel( ' Time in seconds ' ), ylabel ( ' y2=sin100*pi*t2' ),grid on;
subplot(212),stem(t2,y2), xlabel( ' Time in seconds ' ), ylabel ( ' y2=sin100*pi*t2' )

```

Figure 8: Plotting Sine wave.

Lab Task 02:

Write a M file to graphically solve the following fourth order polynomial.

$$Y = X^4 + 2.5X^3 + 2.5X^2 + 10X - 228$$

Here, for the 4th order polynomial there will be total four roots. Probably two of the roots will be complex conjugate. Assume the real roots will be between -5 to 5. So vary the independent variable *X* from -5 to 5 with a step size of 0.01. Calculate the corresponding *Y* values and plot (X,Y). From the plot identify the real roots. [use ‘grid on’ command].

To verify your answer use the MATLAB built in function **roots ( ).**
Type “ roots([1 2.5 2.5 10 -228])” in the command window .

Home Task

[1]. Solve the trigonometric equation Y= Sin θ + Cos θ [-180 < θ < 180].
Given the frequency is 100 Hz. [Ans: -45 degree and 135 degree]

Requirements: The X axis must be labeled in degrees. Submit the printed M file and Plot.
Hints: Since, theta=2 π f t , to plot from -180 to 180 vary t from -0.005 to 0.005 with sufficiently small step size.