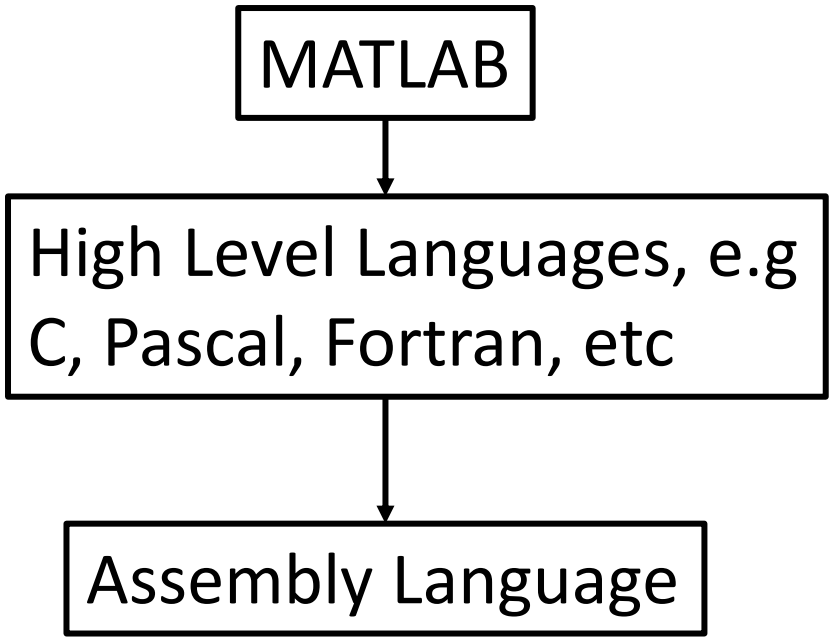
INTRODUCTION TO MATLAB

EEEN 462 – ANALOGUE COMMUNICATION SYSTEMS

Friday, 03 October 2025

WHAT IS MATLAB?

MATLAB is a high level language which has many specialized toolboxes for making program much easier.



(a) In Fortran we multiply two matrices by the code:

```
real*8 A(10,10), B(10,10), C(10,10)
..
...
do i=1,10
do j=1,10
C(i,j) = A(i,j) + B(i,j)
 continue
continue
```

(b) In Matlab we achieve this without declaration and using in one line code:

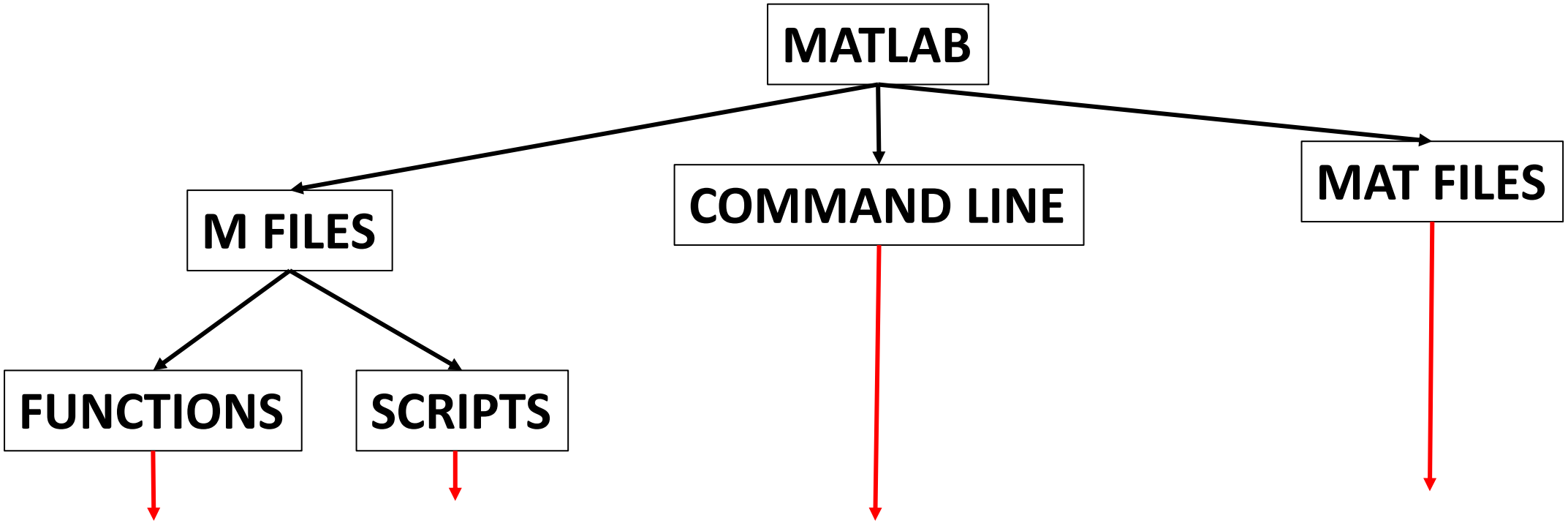
```
C = A*B
```

BRIEF HISTORY OF MATLAB

- **Matlab** was founded in 1984 by Jack Little and Cleve Moler who recognized the need among engineers and scientists for more powerful and productive computation environments beyond that provided existing high level languages, i.e Fortran and C.

- It is distributed by a company **called Mathworks whose Flagship products are MATLAB and SIMULINK**

USING MATLAB



BASIC OPERATORS IN MATLAB

- **Basic arithmetic operator in matlab are: = + - * / ^ ()**
- **Examples:**

```
>> 2+3/4*5
>>  3^2*4
>>  3-4/4-2
>>  (1+i)*( -1+3*i)
>> (1+i)/( -1+3*i)
```

NUMBER FORMATS IN MATLAB

Matlab supports short and long number formats.

Examples:

```
>>  Format short
 >> pi = 3.1416
>> format long
>> pi = 3.1415926535897....
```

VARIABLES IN MATLAB

1. **Variable names** can contain up to 63 characters
2. **Variable names** must start with a letter followed by letters, digits, and underscores.
3. **Variable names** are case sensitive.
4. **Allowed:** a , x1, z2453, A, com_c.
5. **Not allowed:** com-c, 2p, %x, @sign
6. Avoid using special names, e.g. pi

SPECIAL VARIABLES

1. **ans** default variable name for results
2. **Pi** Value of 3.1459…
3. **eps** Smallest incremental number
4. **inf** Infinity
5. **NaN** Not a number e.g. 0/0
6. **realmin** The smallest usable positive real number
7. **realmax** The largest usable positive real number

NUMBER TYPES

- There is no need to declare types. The following is not allowed.

  ~~Int a;~~

  ~~Float b;~~

  ~~Double c~~

- All variables are created with double precision unless specified and they are matrices. Examples

  x=1

  y = 3

  x1 = 5

- After these statements, the variables are 1x1 matrices with double precision

BUILD-IN FUNCTIONS

1. **Trigonometric functions:**

   sin, cos, tan, sec = 1/sin, cosec = 1/cos, cotan=1/tan

2. **inverse trigonometric functions**

   asin, acos, atan ; answer returned in radians,

3. **Exponential**

   y= exp(x)

4. **Logarithm:**

   log(X) to base e, log10(X): log to base 10

5. **Square root:**

   sqrt(x)

INBUILT FUNCTIONS

1. **mean(A):** mean value of a vector
2. **max(A), min (A):** maximum and minimum
3. **sum(A):** summation sort(A): sorted vector
4. **median(A):** median value
5. **std(A):** standard deviation
6. **det(A) :** determinant of a square matrix
7. **dot(a,b):** dot product of two vectors
8. **Cross(a,b):** cross product of two vectors
9. **inv(A):** Inverse of a matrix A
10. **abs(z)** : magnitude of a number

INBUILT FUNCTIONS

fft,ifft,fft2,ifft2: Fast Fourier

dct,idct,dct2,idct2: Discrete Cosine

czt: Chirp-z

radon, iradon: Radon

hilbert: Hilbert

dftmtx: Discrete Fourier matrix

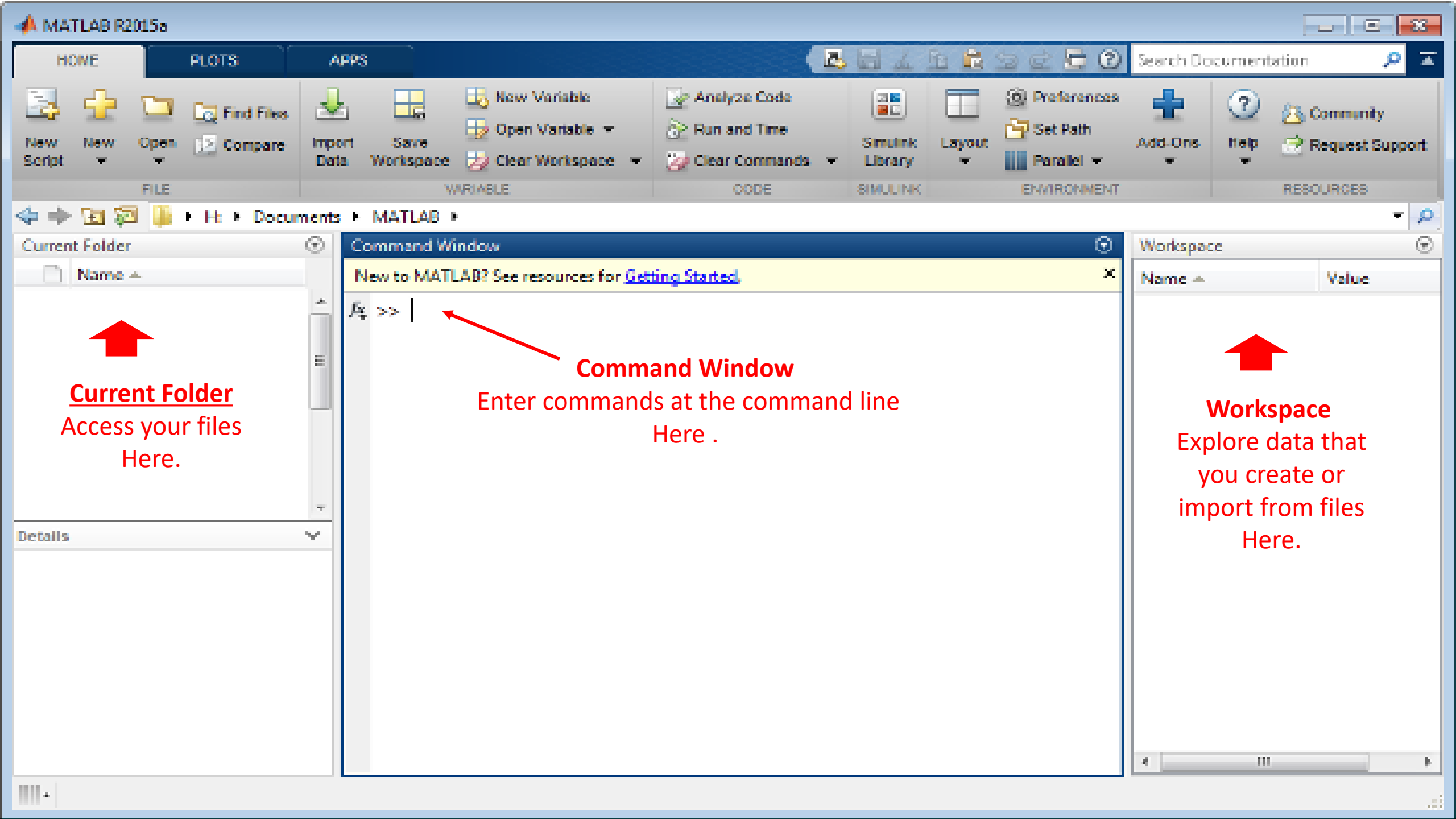
fftshift: Swap vector halves

There are more functions in the signal processing toolbox.

READING & PLAYING AUDIO FILES

1. MATLAB can read, play, write, and even record audio files.

2. You can use the following Matlab commands to read and play audio files:
   a) **wavread** or **auread** to load a file or create a signal yourself.
   b) **sound, soundsc, or wavplay** to play audio.
   c) **wavwrite or auwrite** to save to audio file.
   d) **wavrecord** to record sound from Windows audio input device.


MATLAB R2015a
HOME
PLOTS
APPS
Search Documentation
New Script
New
Open
Find Files
Compare
Import Data
Save Workspace
New Variable
Open Variable
Clear Workspace
Analyze Code
Run and Time
Clear Commands
Simulink Library
Layout
Preferences
Set Path
Parallel
Add-Ons
Help
Community
Request Support
FILE
VARIABLE
CODE
SIMULINK
ENVIRONMENT
RESOURCES
Documents
MATLAB
Current Folder
Name
Details
Command Window
New to MATLAB? See resources for Getting Started
>>
Workspace
Name
Value
Current Folder
Access your files
Here.
Command Window
Enter commands at the command line
Here .
Workspace
Explore data that
you create or
import from files
Here.

CREATING VARIABLES AND FUNCTION CALLS

Enter the following at the command line:

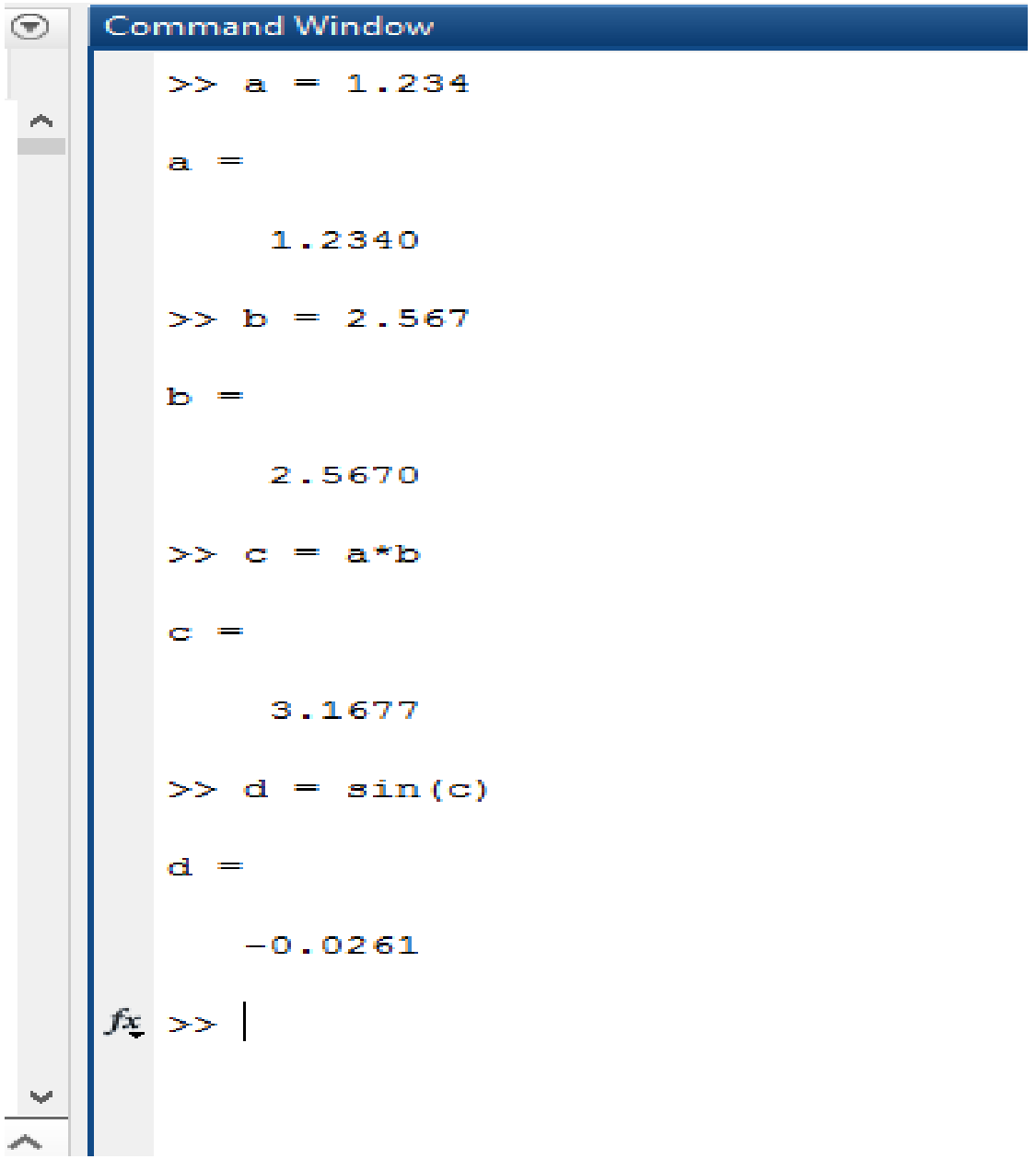
a = 1.234

b = 2.567

c = a * b

d = sin(d)

sin(a)

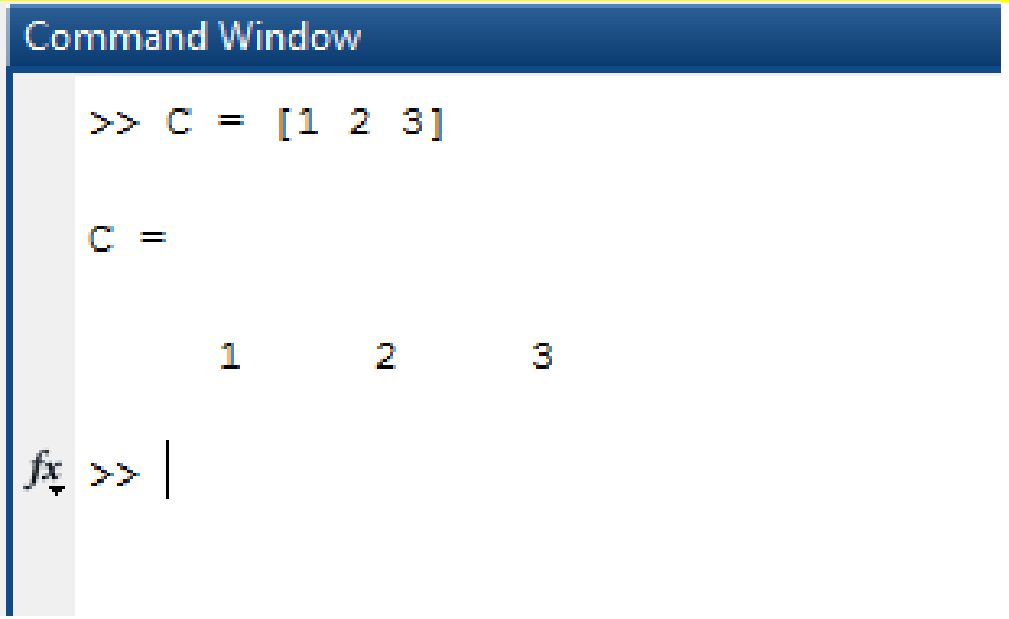


ENTERING MATRICES

1. SINGLE-ROW MATRIX

Enter single Row matrix as follows:

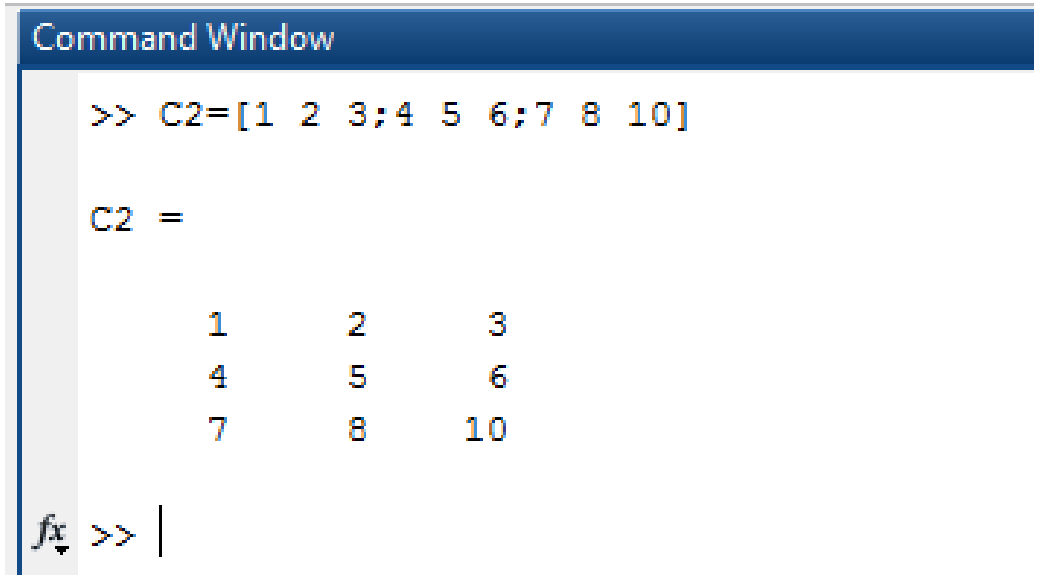
C = [1 2 3]



2. MULTIPLE-ROW MATRIX

Enter Multiple Row matrix as follows:

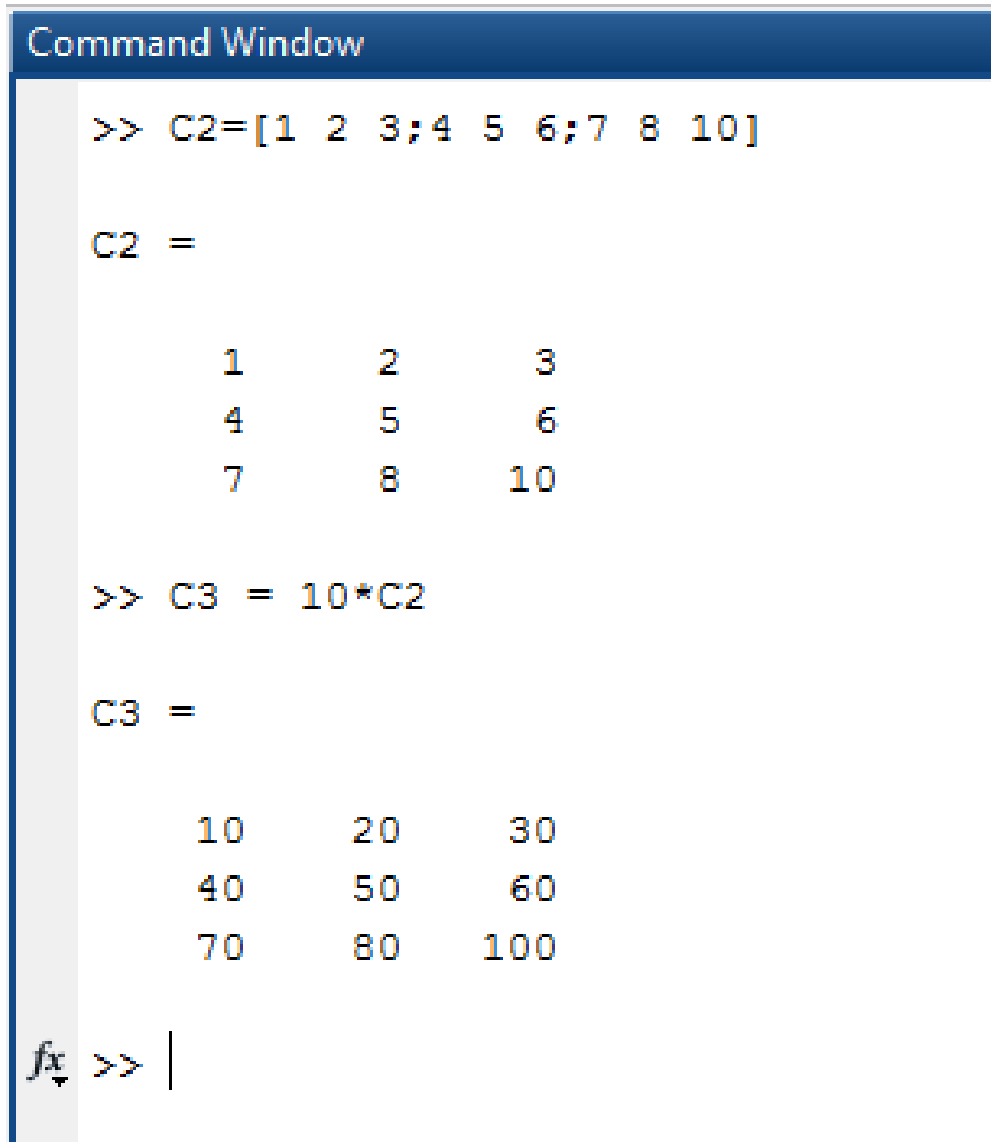
C2= [1 2 3; 4 5 6; 7 8 10]



MULTIPLYING A MATRIX WITH A CONSTANT

Enter

C3 = 10*C2



MULTIPLYING TWO MATRICES

Enter:

C4 = C2*C3

Command Window

```
>> C2=[1 2 3;4 5 6;7 8 10]

C2 =

     1     2     3
     4     5     6
     7     8    10

>> C3 = 10*C2

C3 =

    10    20    30
    40    50    60
    70    80   100

>> C4 = C2*C3

C4 =

   300   360   450
   660   810  1020
  1090  1340  1690
```

TRANSPOSING A MATRIX

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}^T = \begin{bmatrix} a_{11} & a_{21} & a_{31} \\ a_{12} & a_{22} & a_{32} \\ a_{13} & a_{23} & a_{33} \end{bmatrix}$$

Enter

C5 = C4’

Command Window

```
C3 =

    10    20    30
    40    50    60
    70    80   100

>> C4 = C2*C3

C4 =

         300         360         450
         660         810        1020
        1090        1340        1690

>> C5 = c4'
Undefined function or variable 'c4'.

Did you mean:
>> C5 = C4'

C5 =

         300         660        1090
         360         810        1340
         450        1020        1690
```

GETTING THE INVERSE OF A MATRIX

Type:

C6 = C5*inv(C5)

Command Window

```
          660         810        1020
         1090        1340        1690

>> C5 = c4'
Undefined function or variable 'c4'.

Did you mean:
>> C5 = C4'

C5 =

          300         660        1090
          360         810        1340
          450        1020        1690

>> C6 = C5*INV(C5)
Undefined function 'INV' for input arguments of type 'double'.

Did you mean:
>> C6 = C5*inv(C5)

C6 =

    1.0000    0.0000   -0.0000
   -0.0000    1.0000   -0.0000
   -0.0000    0.0000    1.0000
```

CHANGING NUMBER FORMAT USING LONG TO SHORT COMMANDS

Type:

>> Format short

>> C7=C5*inv(C5)

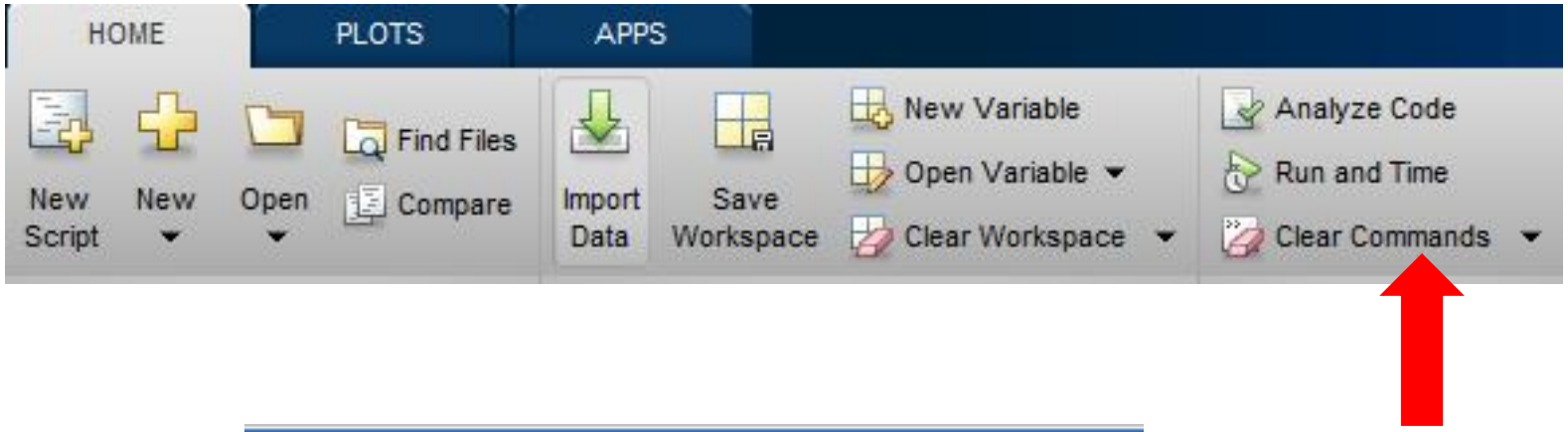
>> Format long

>>> C7=C5*inv(C5)

```
>> format short
>> C7 = C5*inv(C5)

C7 =

    1.0000    0.0000   -0.0000
   -0.0000    1.0000   -0.0000
   -0.0000    0.0000    1.0000

>> format long
>> C8=C5*inv(C5)

C8 =

   0.999999999999965   0.000000000000203  -0.000000000000184
  -0.000000000000001   0.999999999999936  -0.000000000000115
  -0.000000000000044   0.000000000000018   0.999999999999912
```

CARRYING OUT BITWISE MATRIX MULTIPLICATION

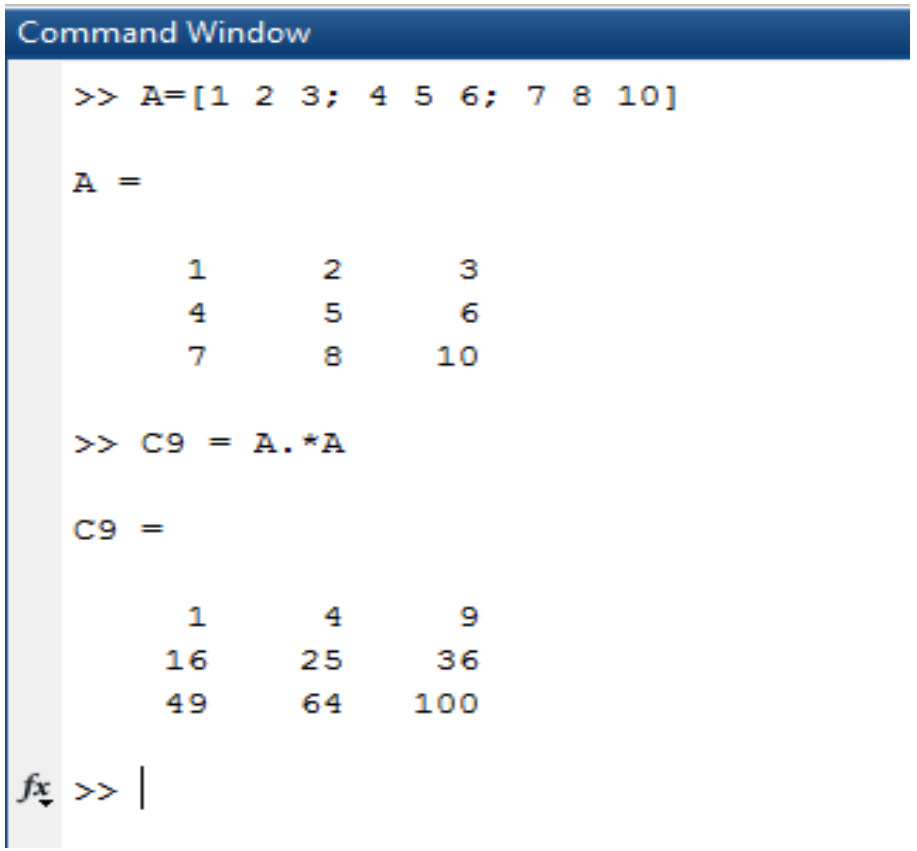
1. Clear Command window



2. Enter

A = [1 2 3; 4 5 6; 7 8 10]

C9 = A.*A



DIVIDING A MATRIX WITH A CONSTANT

Enter

C10 = C9/4

```
>> A=[1 2 3; 4 5 6; 7 8 10]

A =

     1     2     3
     4     5     6
     7     8    10

>> C9 = A.*A

C9 =

     1     4     9
    16    25    36
    49    64   100

>> C10 = C9/4

C10 =

   0.250000000000000   1.000000000000000   2.250000000000000
   4.000000000000000   6.250000000000000   9.000000000000000
  12.250000000000000  16.000000000000000  25.000000000000000
```

RAISING A MATRIX TO A POWER OF X

Enter

C1 = A^3

```
>> C1 = A^3

C1 =

         489         600         756
        1104        1353        1704
        1828        2240        2821
```

CONCATATION OF MATRICES

Enter

C = [A, A]

```
>> C2 = [A,A]

C2 =

     1     2     3     1     2     3
     4     5     6     4     5     6
     7     8    10     7     8    10
```

Enter

D = [A; A]

```
>> C3 = [A; A]

C3 =

     1     2     3
     4     5     6
     7     8    10
     1     2     3
     4     5     6
     7     8    10
```

COMPLEX MATRICES

1. Clear Command Window

2. Enter

>> Sqrt(-1)

Command Window

```
>> sqrt(-1)

ans =

   0.000000000000000 + 1.000000000000000i
```

3. Enter

C = [3+4i, 4+3i; -i, 10i]

```
>> C = [3+4i, 4+3i; -i, 10i]

C =

   3.000000000000000 + 4.000000000000000i   4.000000000000000 + 3.000000000000000i
   0.000000000000000 - 1.000000000000000i   0.000000000000000 +10.000000000000000i
```

COLON OPERATOR

The colon (:) is use in defining a vector range as illustrated below.

```
>> x = 7:12

x =

7    8    9   10   11   12

>> x = 7:2.5:12

x =

7.0000   9.5000  12.0000

>> x = 12:-1:7

x =

12   11   10    9    8    7
```