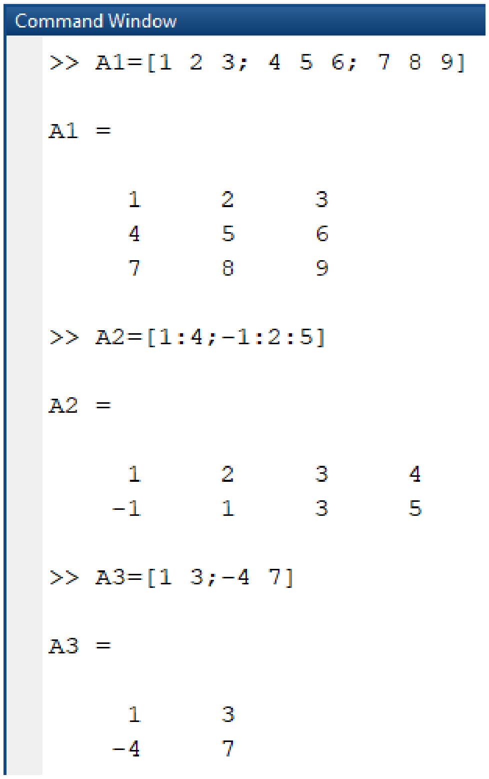
MATRICES

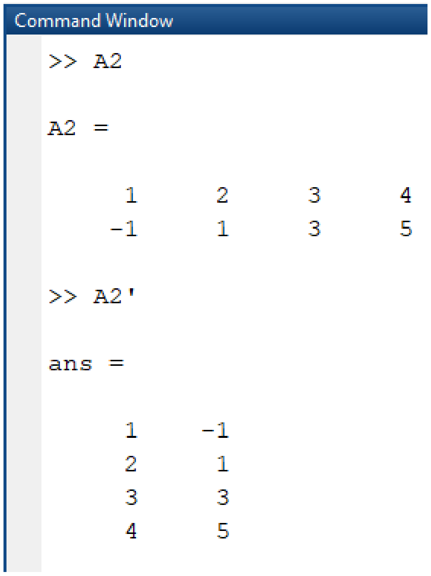
Def: - A matrix in Matlab is similar to defining a vector commas or spaces are used to separate elements in a row and semi colons are used to separate individual rows.

Ex:- $A_1 = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$



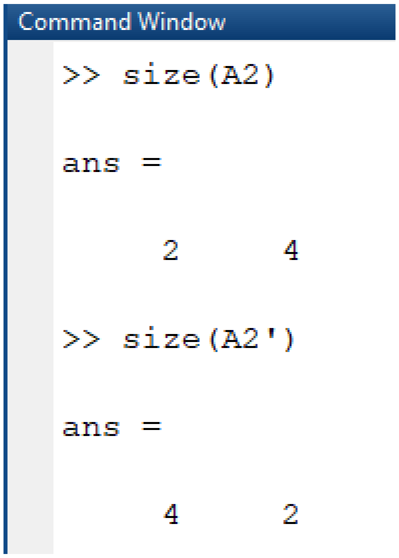
```
>> A1=[1 2 3; 4 5 6; 7 8 9]

A1 =

     1     2     3
     4     5     6
     7     8     9

>> A2=[1:4;-1:2:5]

A2 =

     1     2     3     4
    -1     1     3     5

>> A3=[1 3;-4 7]

A3 =

     1     3
    -4     7
```

Transpose of matrix interchange rows with the corresponding column



```
>> A2

A2 =

     1     2     3     4
    -1     1     3     5

>> A2'

ans =

     1    -1
     2     1
     3     3
     4     5
```

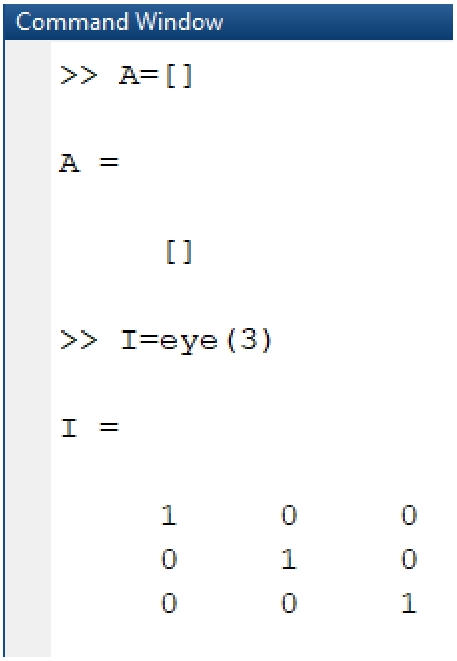
To find the dimension of matrix use command **size(A**) where A is matrix



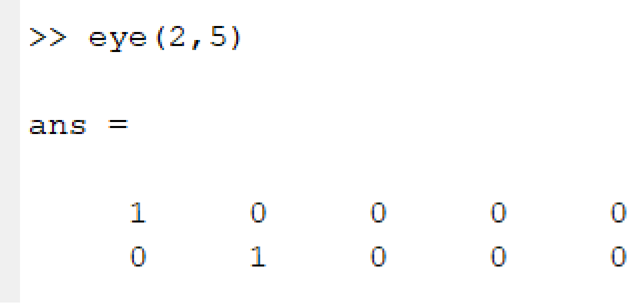
```
>> size(A2)

ans =

     2     4

>> size(A2')

ans =

     4     2
```

Special Matrices

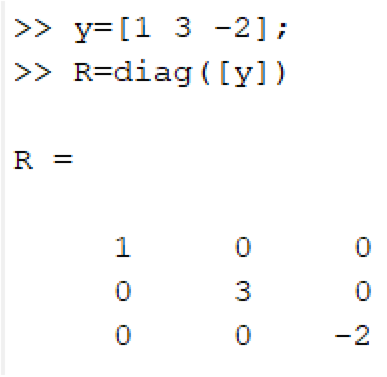
E=[ ]   % empty 0-by-0 matrix



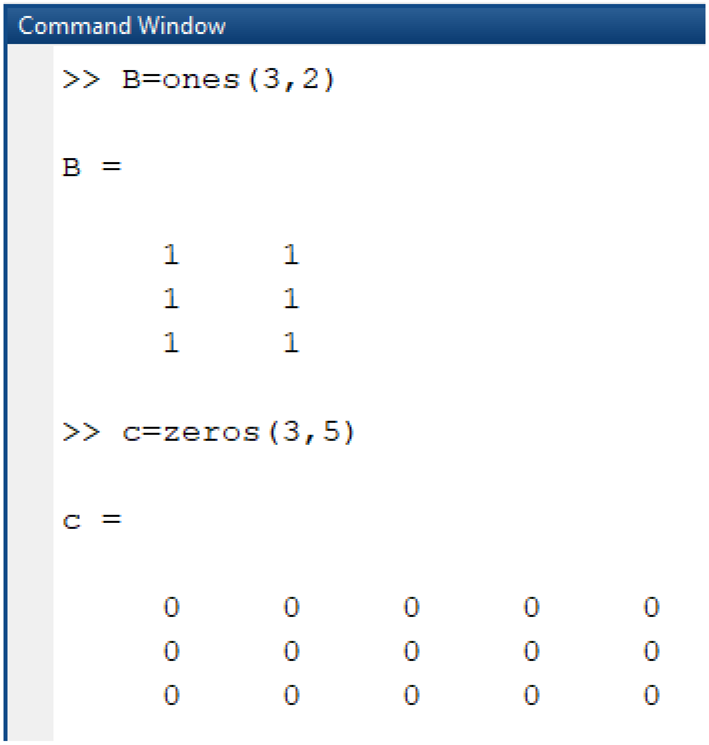
```
>> A=[]

A =

     []

>> I=eye(3)

I =

     1     0     0
     0     1     0
     0     0     1
```



```
>> eye(2,5)

ans =

     1     0     0     0     0
     0     1     0     0     0
```



```
>> y=[1 3 -2];
>> R=diag([y])

R =

     1     0     0
     0     3     0
     0     0    -2
```



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

B =

     1     1
     1     1
     1     1

>> c=zeros(3,5)

c =

     0     0     0     0     0
     0     0     0     0     0
     0     0     0     0     0
```

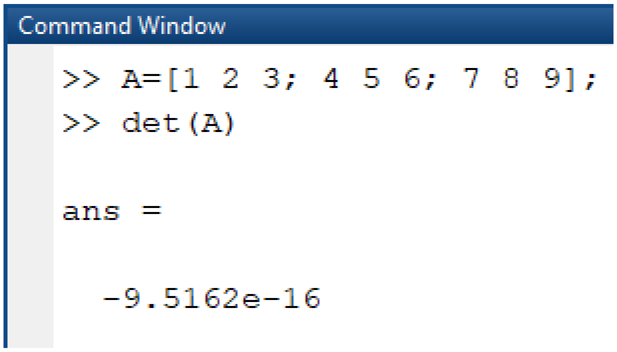
To find determinant of matrix use command **det(A)** where A is matrix

The *determinant* of a square matrix is a number. For a 2×2 matrix, the determinant is given by:

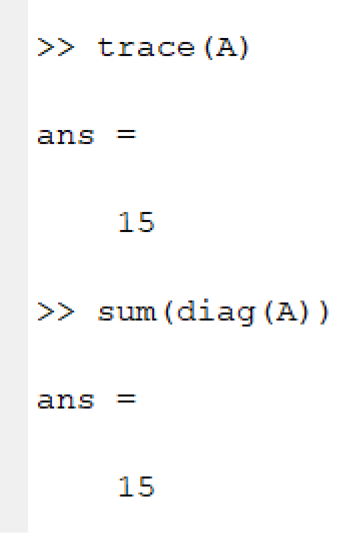
$$D = \begin{vmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{vmatrix} = a_{11}a_{22} - a_{12}a_{21}$$

To calculate the determinant of a matrix A in MATLAB, simply write **det(A)**. Here is the determinant of a 2×2 matrix:

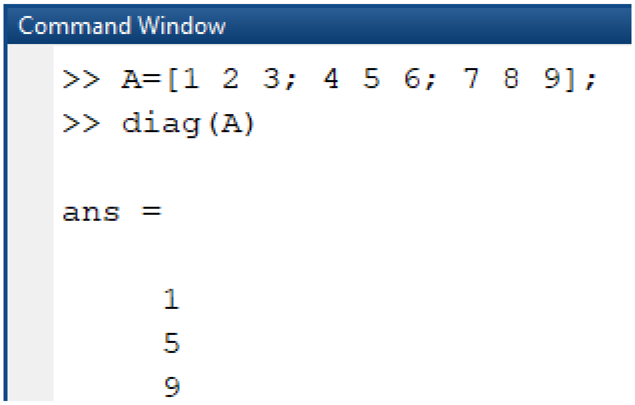
```
>> A = [1 3; 4 5];

>> det(A)

ans =

        –7
```



```
>> A=[1 2 3; 4 5 6; 7 8 9];
>> det(A)

ans =

  -9.5162e-16
```



```
>> trace(A)

ans =

    15

>> sum(diag(A))

ans =

    15
```



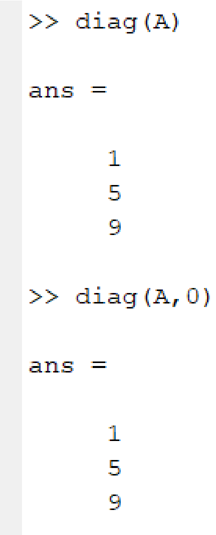
```
>> A=[1 2 3; 4 5 6; 7 8 9];
>> diag(A)

ans =

     1
     5
     9
```

Diag(A,k)

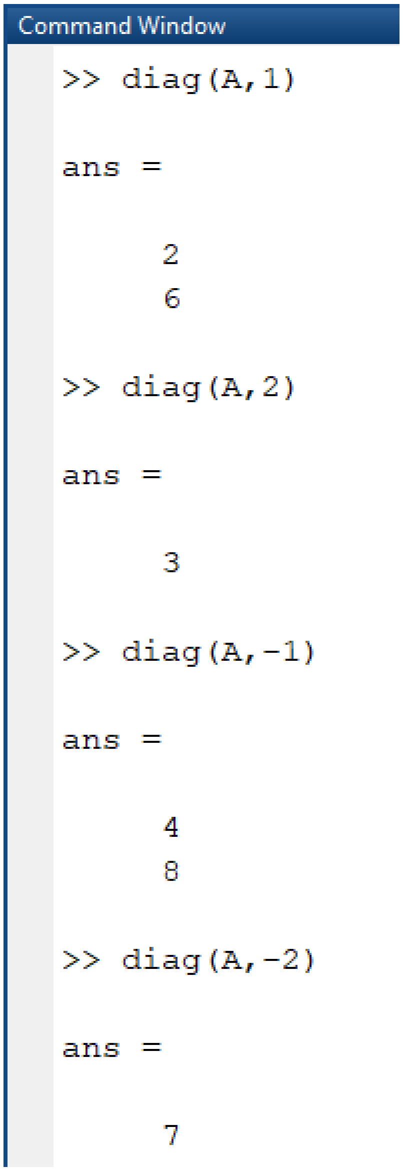
If $k = 0$ that mean the diagonal of matrix

If $k > 0$ that mean the upper diagonal of matrix

If $k < 0$ that mean the lawer diagonal of matrix

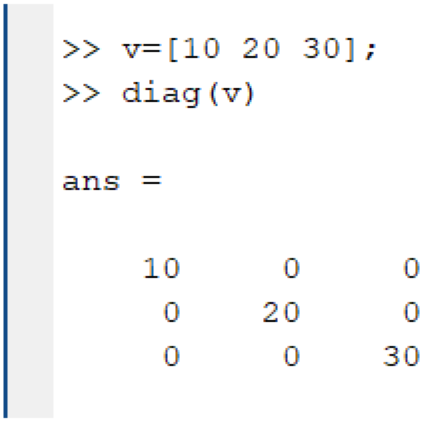


```
>> diag(A)

ans =

     1
     5
     9

>> diag(A,0)

ans =

     1
     5
     9
```



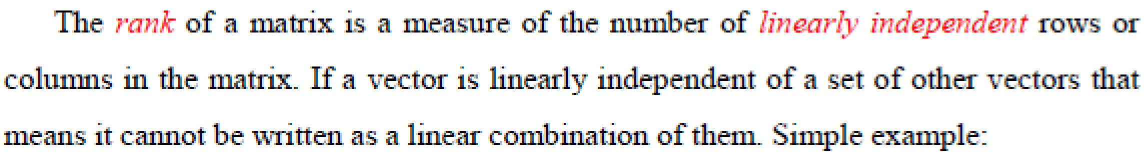
```
>> diag(A,1)

ans =

     2
     6

>> diag(A,2)

ans =

     3

>> diag(A,-1)

ans =

     4
     8

>> diag(A,-2)

ans =

     7
```

Example: -

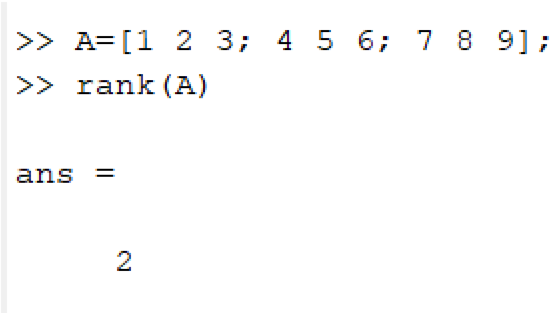


```
>> v=[10 20 30];
>> diag(v)

ans =

    10     0     0
     0    20     0
     0     0    30
```

To find rank use command **rank(A)** where A is matrix

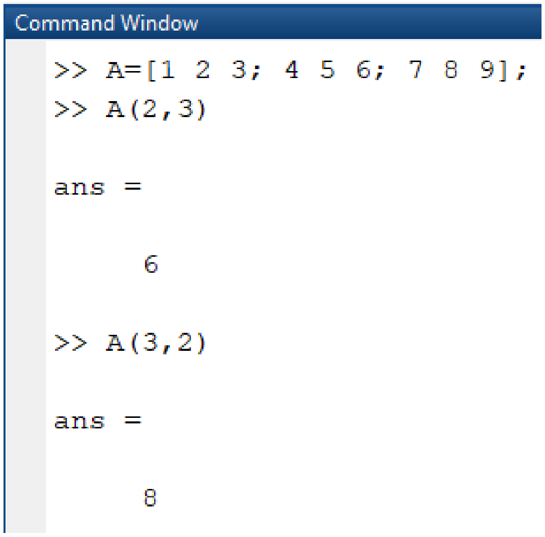


The *rank* of a matrix is a measure of the number of *linearly independent* rows or columns in the matrix. If a vector is linearly independent of a set of other vectors that means it cannot be written as a linear combination of them. Simple example:

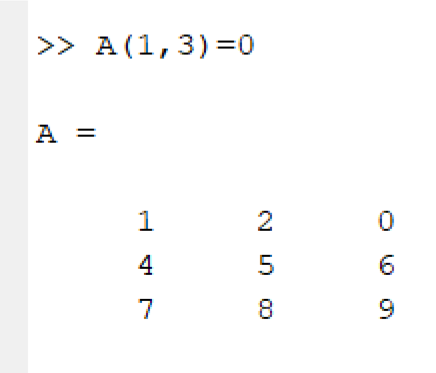


```
>> A=[1 2 3; 4 5 6; 7 8 9];
>> rank(A)

ans =

     2
```

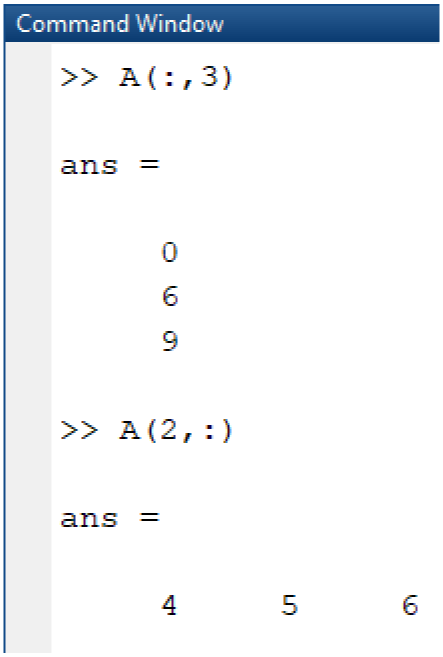
To find the value of location of matrix you can do the following



```
>> A=[1 2 3; 4 5 6; 7 8 9];
>> A(2,3)

ans =

     6

>> A(3,2)

ans =

     8
```

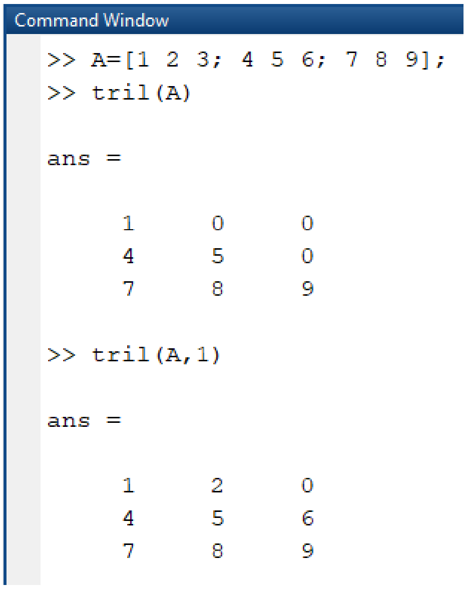


```
>> A(1,3)=0

A =

     1     2     0
     4     5     6
     7     8     9
```

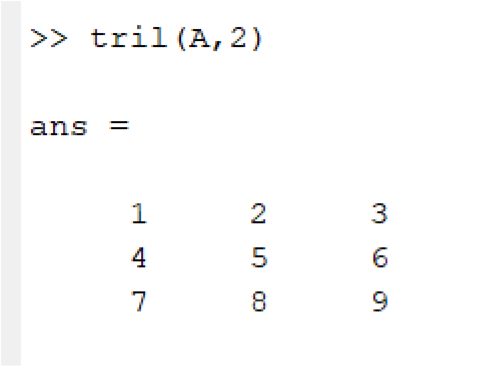


```
>> A(:,3)

ans =

     0
     6
     9

>> A(2,:)

ans =

     4     5     6
```

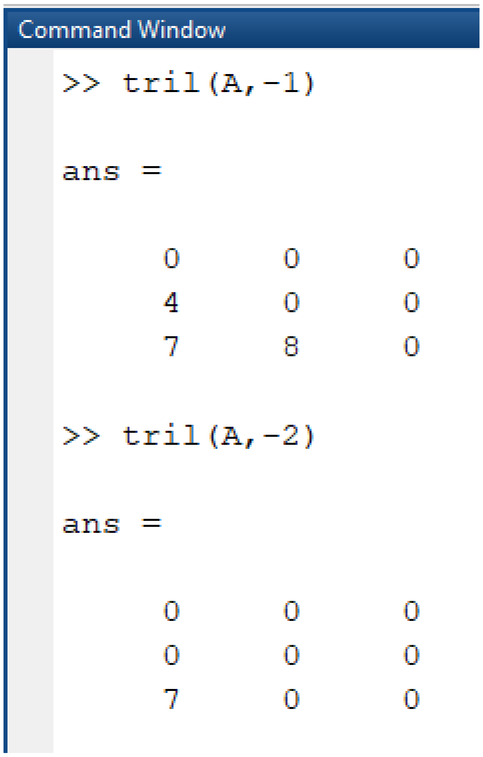
To find loawer and upper triangler of matrix



```
>> A=[1 2 3; 4 5 6; 7 8 9];
>> tril(A)

ans =

     1     0     0
     4     5     0
     7     8     9

>> tril(A,1)

ans =

     1     2     0
     4     5     6
     7     8     9
```



```
>> tril(A,2)

ans =

     1     2     3
     4     5     6
     7     8     9
```



```
>> tril(A,-1)

ans =

     0     0     0
     4     0     0
     7     8     0

>> tril(A,-2)

ans =

     0     0     0
     0     0     0
     7     0     0
```

Variable

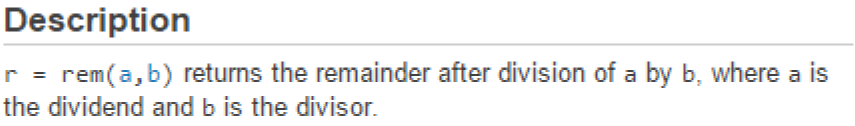
1- they may not start with anumeral

2- matlab in case sensitive $\boldsymbol{A}$ and $\boldsymbol{a}$ are different variable

3- we can not user the words such as **for , if , switch, else , if ,…**

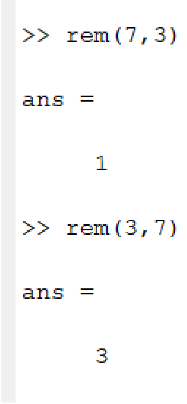
Mathematical matlab command

Mathematical Expression	Matlab Command
$sinx\,,cosx$	Sin(x), cos(x)
$\tan^{-1} x$	atan(x)
$sinhx$	sinh(x)
e^{x}	exp(x)
Reminder	rem(a,b)
True for real number	isreal(x)
x^{b}	x^b
$\sqrt{x}$	sqrt(x) or x^0.5
$\lvert x\rvert$	abs(x)
lnx, logx	log(x) , log10(x)
π	pi
a±b	a±b
ab	a*b
Round toword zero	fix(x)
Round toword $-\infty$	floor(x)
Round toword $+\infty$	ceil(x)
Round to nearest integer	round(x)



Description

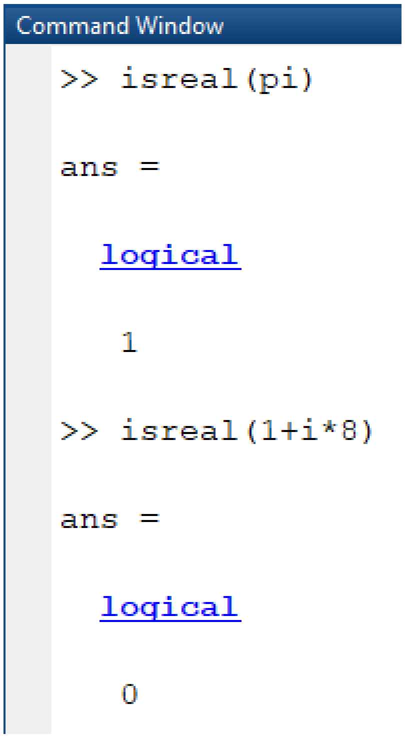
r = rem(a,b) returns the remainder after division of a by b, where a is the dividend and b is the divisor.



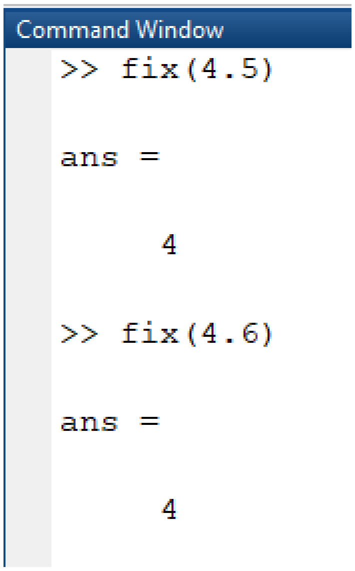
```
>> rem(7,3)

ans =

     1

>> rem(3,7)

ans =

     3
```

3+3+1 here 1 is reminder

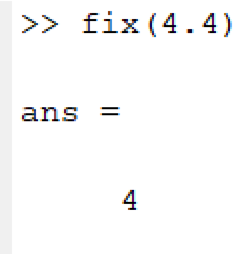
0+3 here 3 is reminder



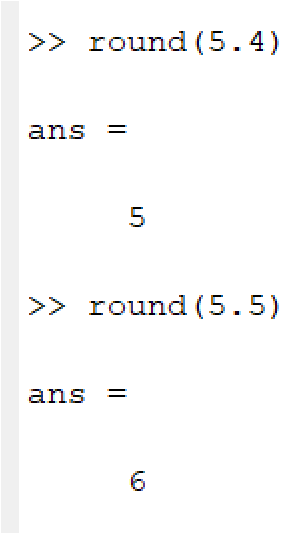
```
>> isreal(pi)

ans =

  logical

   1

>> isreal(1+i*8)

ans =

  logical

   0
```



```
>> fix(4.5)

ans =

     4

>> fix(4.6)

ans =

     4
```

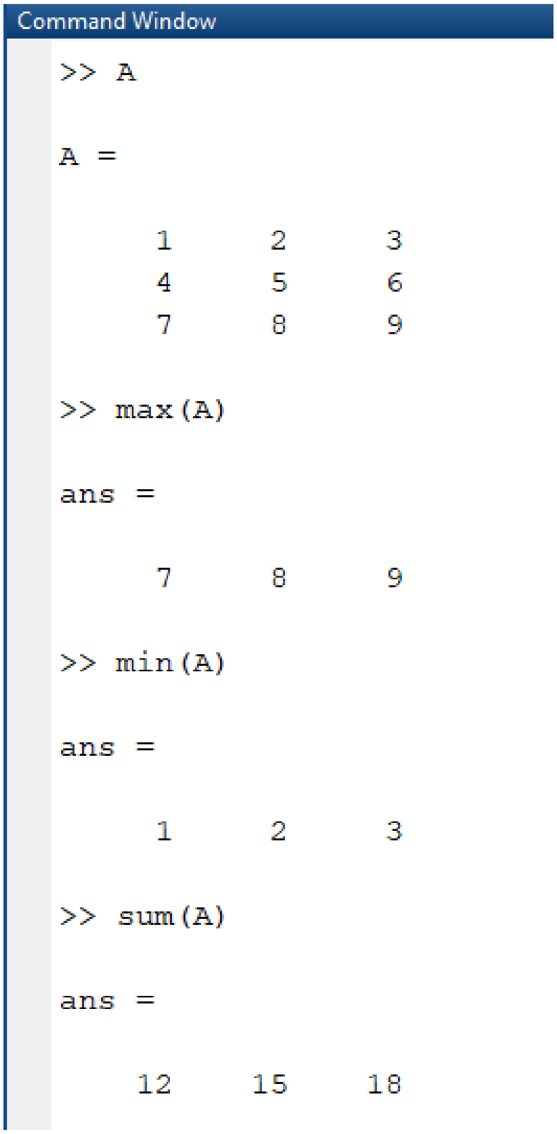


```
>> fix(4.4)

ans =

     4
```

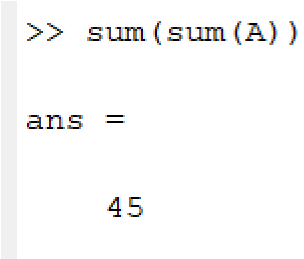


```
>> round(5.4)

ans =

     5

>> round(5.5)

ans =

     6
```

To find maximum or minimum or summation use the following commands



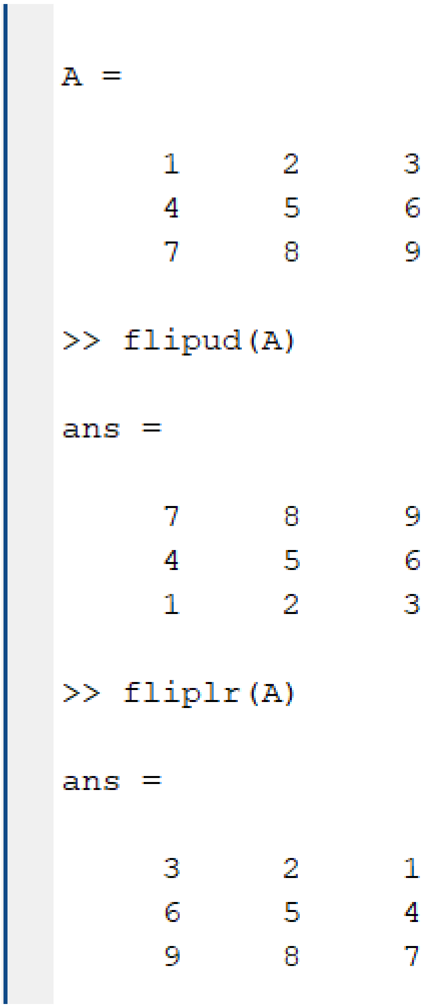
```
>> A

A =

     1     2     3
     4     5     6
     7     8     9

>> max(A)

ans =

     7     8     9

>> min(A)

ans =

     1     2     3

>> sum(A)

ans =

    12    15    18
```



```
>> sum(sum(A))

ans =

    45
```

flip

flip(A) returns array B the same size as A, but with the order of the elements reversed ,If A is a matrix, then flip(A) reverses the elements in each column.



```
A =

     1     2     3
     4     5     6
     7     8     9

>> flipud(A)

ans =

     7     8     9
     4     5     6
     1     2     3

>> fliplr(A)

ans =

     3     2     1
     6     5     4
     9     8     7
```

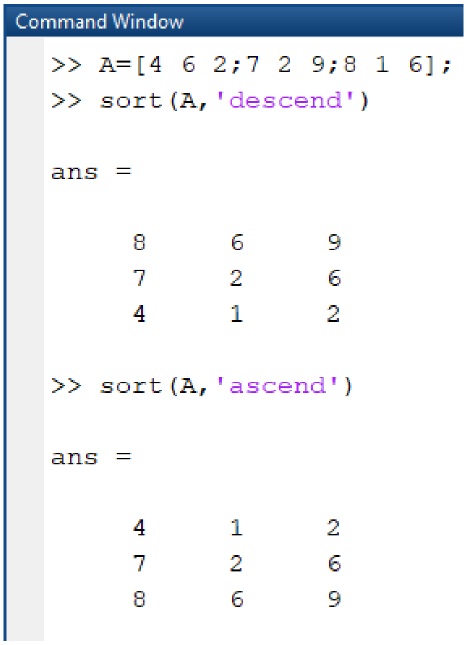
rot90

rot90(A) rotates array A counterclockwise by 90 degrees. For multidimensional arrays, rot90 rotates in the plane formed by the first and second dimensions.

```
>> rot90(A)

ans =

     3     6     9
     2     5     8
     1     4     7

>> rot90(A,2)

ans =

     9     8     7
     6     5     4
     3     2     1

>> rot90(A,4)

ans =

     1     2     3
     4     5     6
     7     8     9
```

Sort of matrix

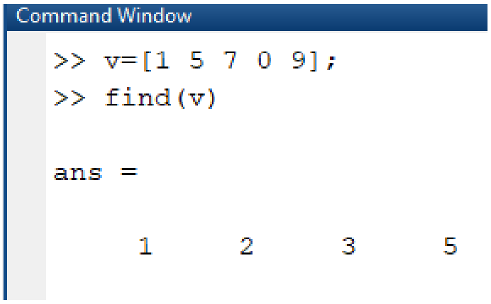
sort(A, direction) sorts the elements of A in ascending order



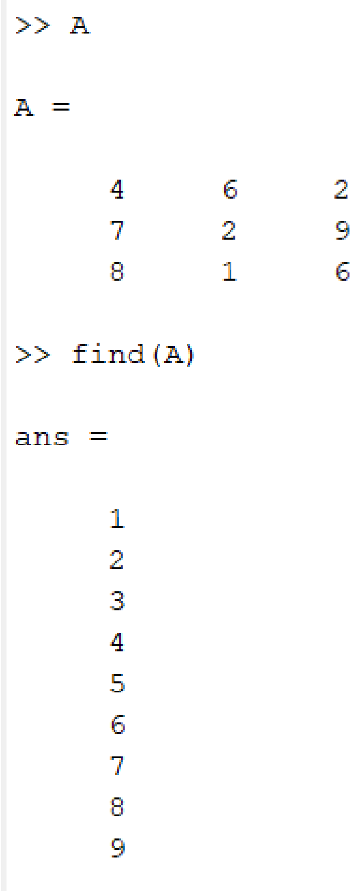
```
>> A=[4 6 2;7 2 9;8 1 6];
>> sort(A,'descend')

ans =

     8     6     9
     7     2     6
     4     1     2

>> sort(A,'ascend')

ans =

     4     1     2
     7     2     6
     8     6     9
```

Command (Find(x))

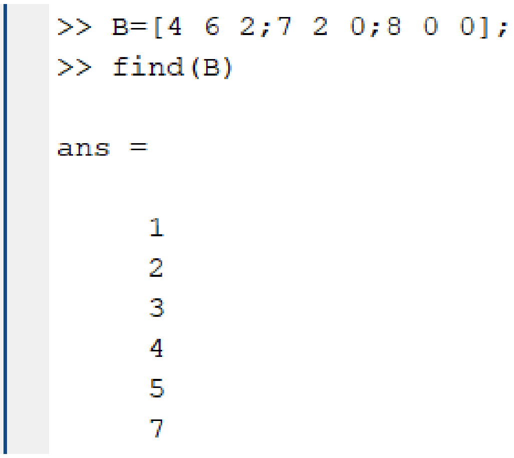
find(X) returns a vector containing the linear indices of each nonzero element in array X.



```
>> v=[1 5 7 0 9];
>> find(v)

ans =

     1     2     3     5
```



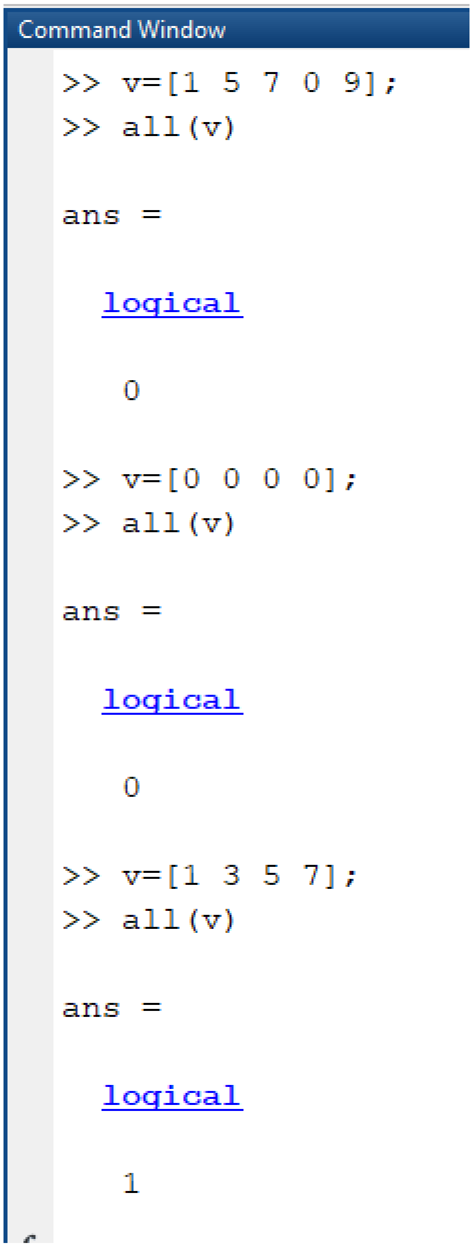
```
>> A

A =

     4     6     2
     7     2     9
     8     1     6

>> find(A)

ans =

     1
     2
     3
     4
     5
     6
     7
     8
     9
```



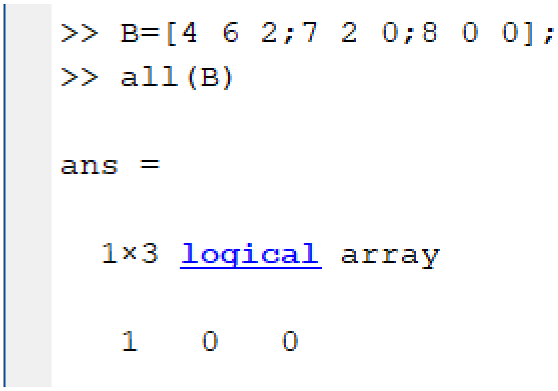
```
>> B=[4 6 2;7 2 0;8 0 0];
>> find(B)

ans =

     1
     2
     3
     4
     5
     7
```

Command (all(A))

all(A) tests along the first array dimension of A whose size does not equal 1, and determines if the elements are all nonzero or logical 1 (true). In practice, allis a natural extension of the logical AND operator.



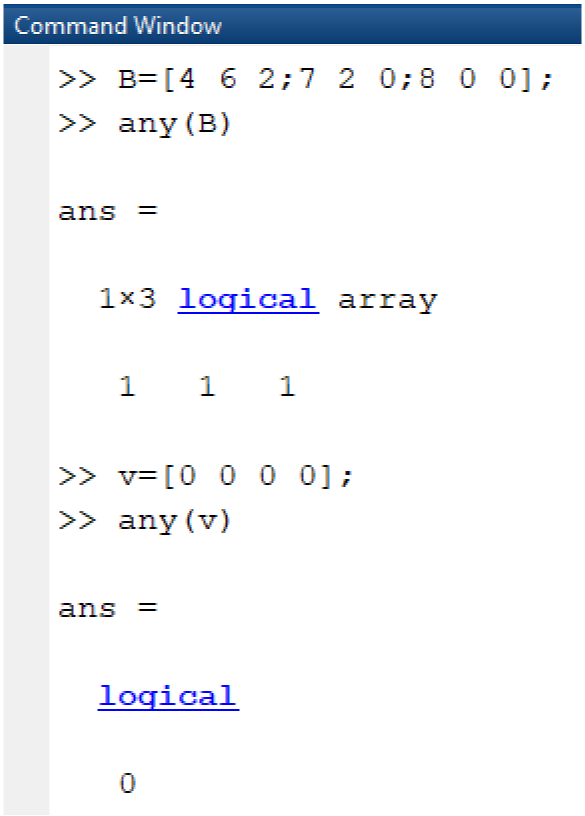
```
>> v=[1 5 7 0 9];
>> all(v)

ans =

  logical

   0

>> v=[0 0 0 0];
>> all(v)

ans =

  logical

   0

>> v=[1 3 5 7];
>> all(v)

ans =

  logical

   1
```



```
>> B=[4 6 2;7 2 0;8 0 0];
>> all(B)

ans =

  1×3 logical array

   1   0   0
```

Command (any(A))

any(A) tests along the first array dimension of A whose size does not equal 1, and determines if any element is a nonzero number or logical 1 (true). In practice, any is a natural extension of the logical OR operator



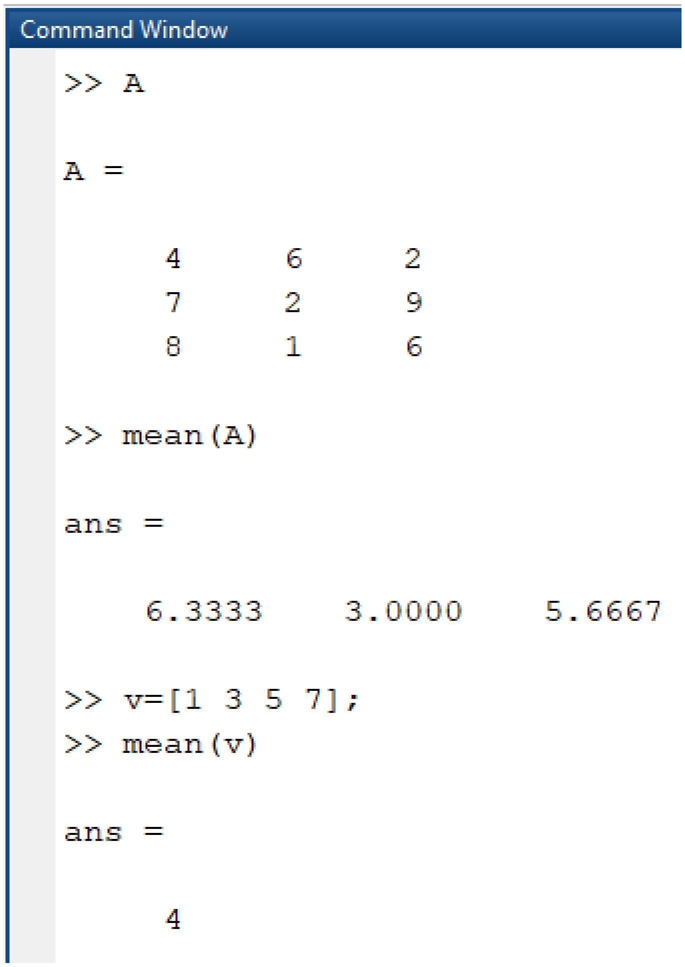
```
>> B=[4 6 2;7 2 0;8 0 0];
>> any(B)

ans =

  1×3 logical array

   1   1   1

>> v=[0 0 0 0];
>> any(v)

ans =

  logical

   0
```

Command (mean “Average or mean value of array”)

mean(A) returns the mean of the elements of A along the first array dimension whose size does not equal 1.

If A is a vector, then mean(A) returns the mean of the elements.

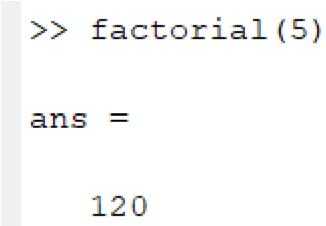
If A is a matrix, then mean(A) returns a row vector containing the mean of each column.



```
>> A

A =

     4     6     2
     7     2     9
     8     1     6

>> mean(A)

ans =

    6.3333    3.0000    5.6667

>> v=[1 3 5 7];
>> mean(v)

ans =

     4
```

Command (factorial)

factorial(n) returns the product of all positive integers less than or equal to n, where n is a nonnegative integer value. If n is an array, then f contains the factorial of each value of n. The data type and size of f is the same as that of n.

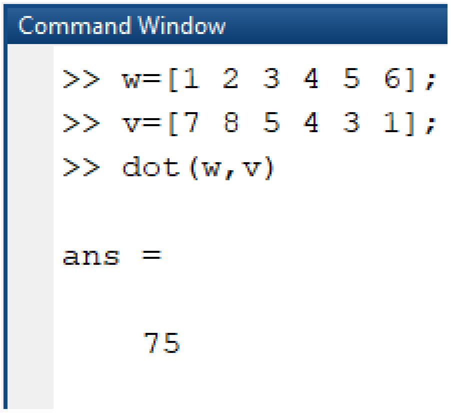


```
>> factorial(5)

ans =

   120
```

Command (Dot product)

dot(A,B) returns the scalar dot product of A and B.

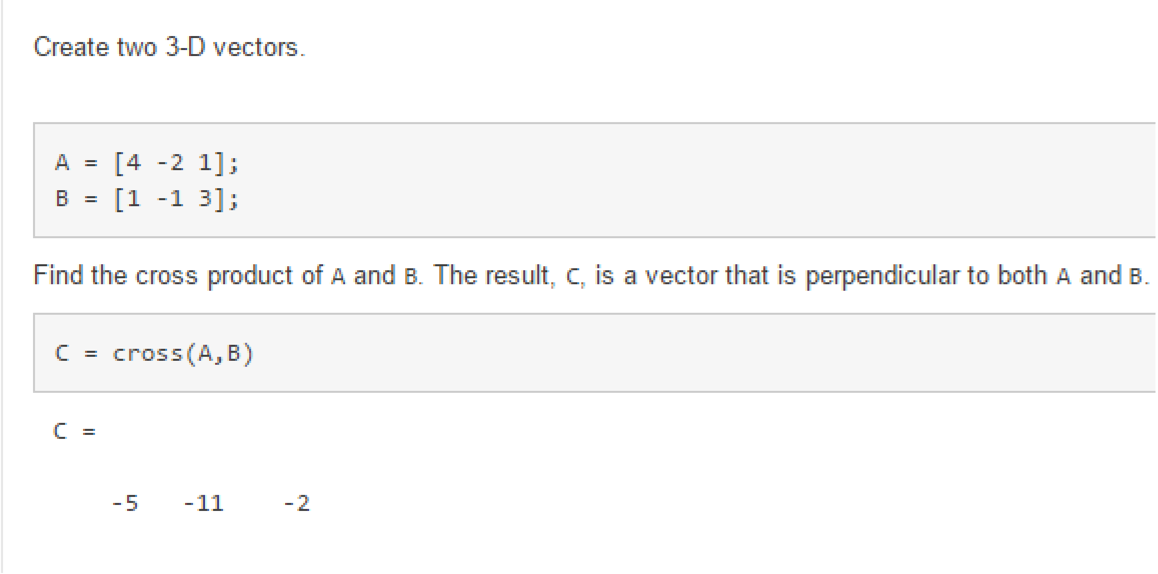
If A and B are vectors, then they must have the same length.



```
>> w=[1 2 3 4 5 6];
>> v=[7 8 5 4 3 1];
>> dot(w,v)

ans =

    75
```

Command (Cross product)

cross(A,B) returns the cross product of A and B. must be 3 dim mean A=[a1]



Create two 3-D vectors.

```
A = [4 -2 1];
B = [1 -1 3];
```

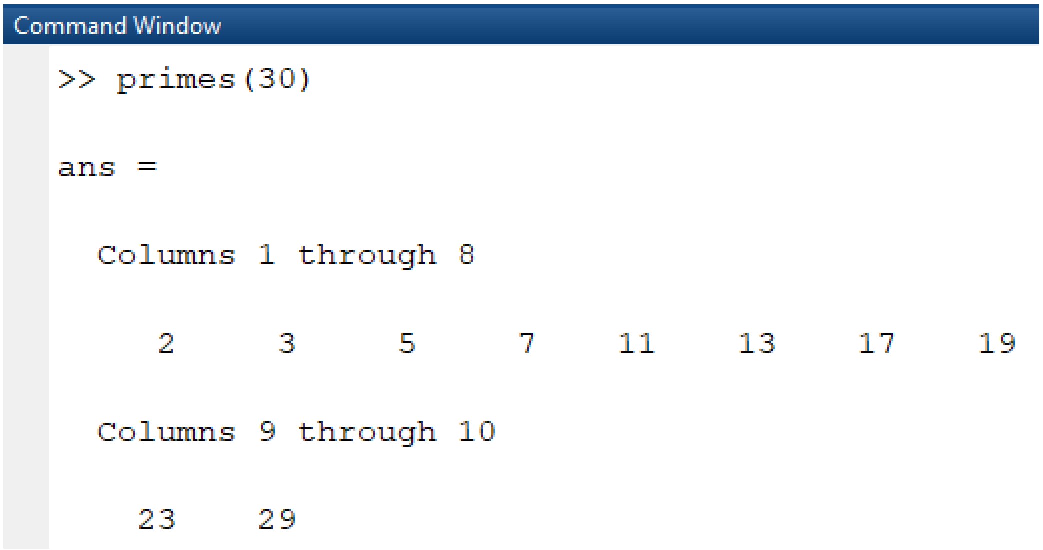
Find the cross product of A and B. The result, C, is a vector that is perpendicular to both A and B.

```
C = cross(A,B)
```

```
C =

    -5   -11    -2
```

Command (primes)

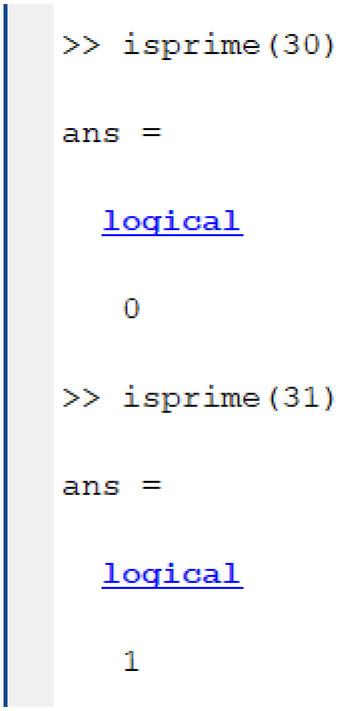
primes(n) returns a row vector containing all the prime numbers less than or equal to n. The data type of p is the same as that of n.



```
>> primes(30)

ans =

  Columns 1 through 8

     2     3     5     7    11    13    17    19

  Columns 9 through 10

    23    29
```

isprime(X)

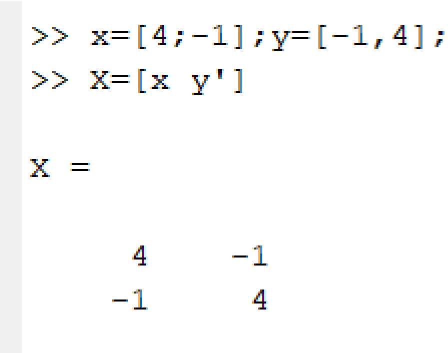
isprime(X) returns a logical array the same size as X. The value at TF(i) is true when X(i) is a prime number. Otherwise, the value is false



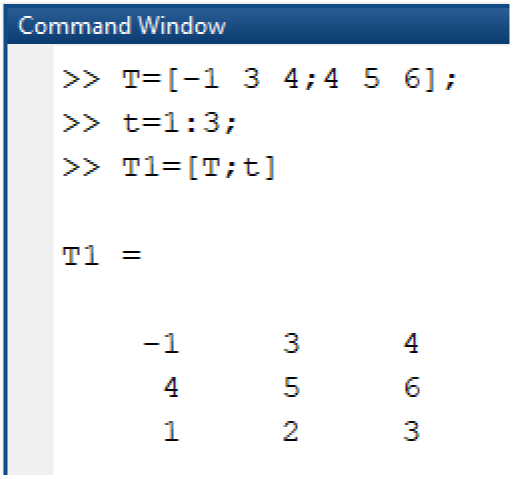
```
>> isprime(30)

ans =

  logical

   0

>> isprime(31)

ans =

  logical

   1
```

Building matrices and extracting part of matrices

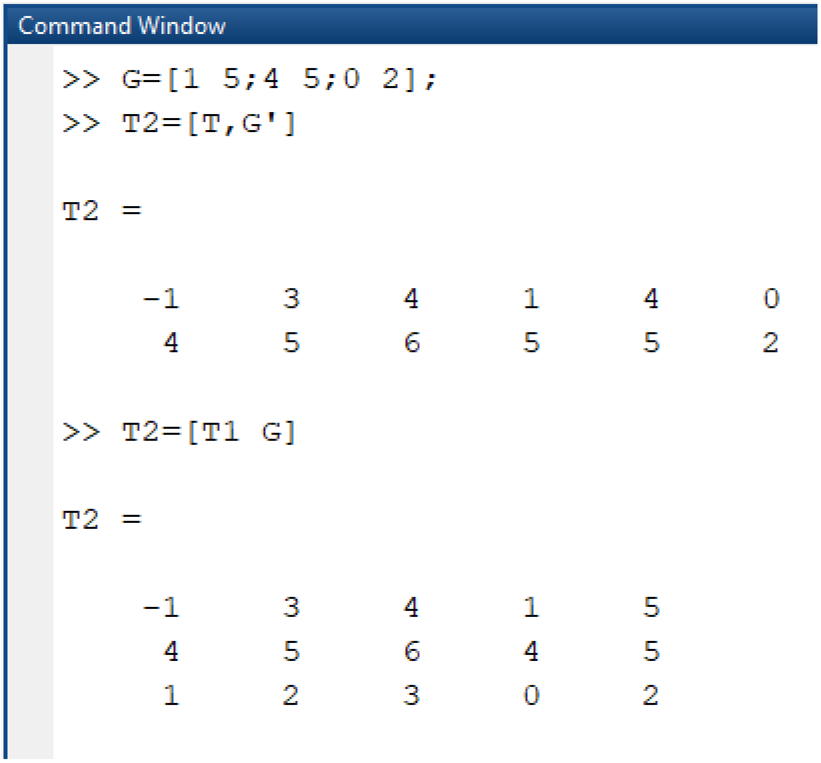
Example 1:-



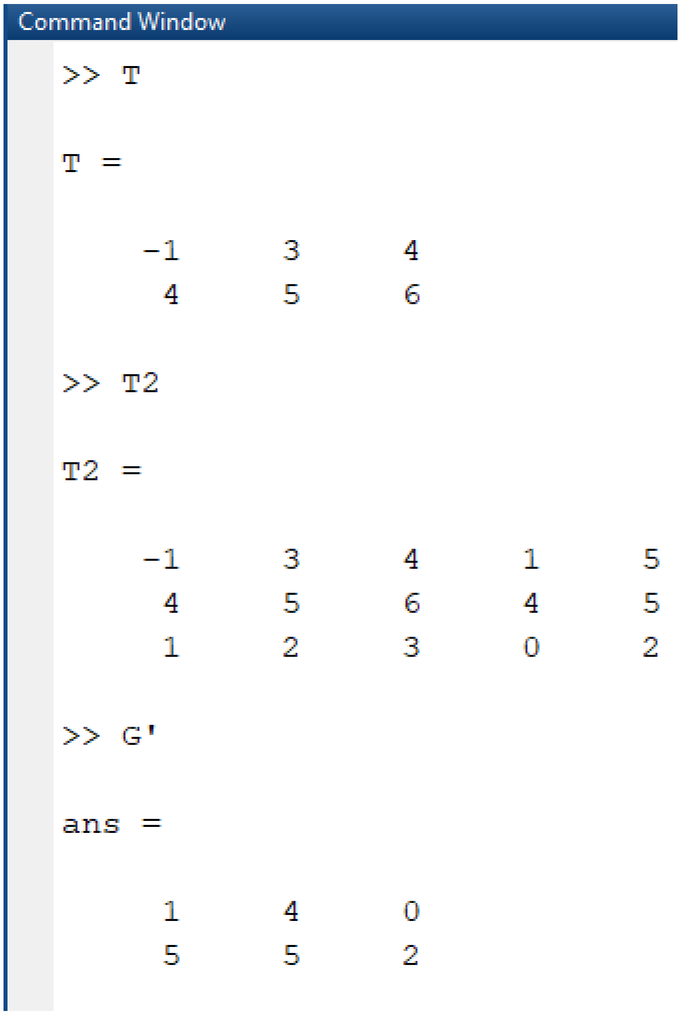
```
>> x=[4;-1];y=[-1,4];
>> X=[x y']

X =

     4    -1
    -1     4
```



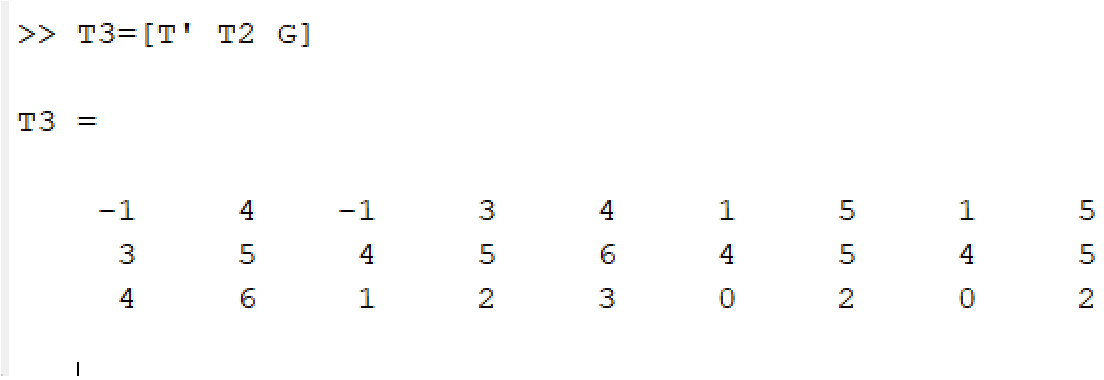
```
>> T=[-1 3 4;4 5 6];
>> t=1:3;
>> T1=[T;t]

T1 =

    -1     3     4
     4     5     6
     1     2     3
```



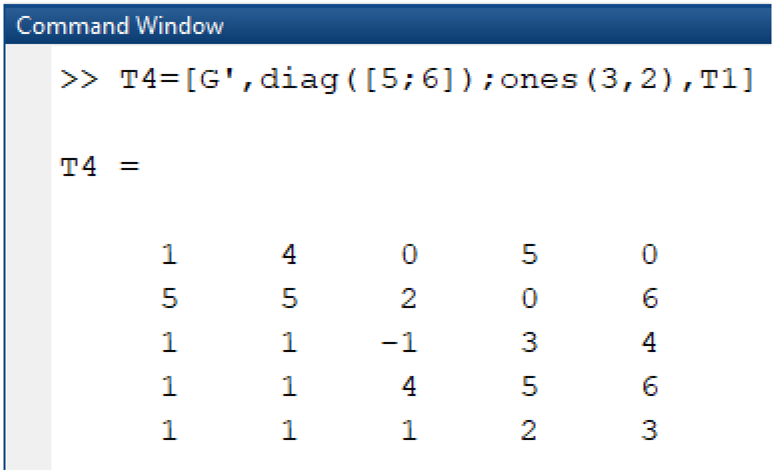
```
>> G=[1 5;4 5;0 2];
>> T2=[T,G']

T2 =

    -1     3     4     1     4     0
     4     5     6     5     5     2

>> T2=[T1 G]

T2 =

    -1     3     4     1     5
     4     5     6     4     5
     1     2     3     0     2
```



```
>> T

T =

    -1     3     4
     4     5     6

>> T2

T2 =

    -1     3     4     1     5
     4     5     6     4     5
     1     2     3     0     2

>> G'

ans =

     1     4     0
     5     5     2
```

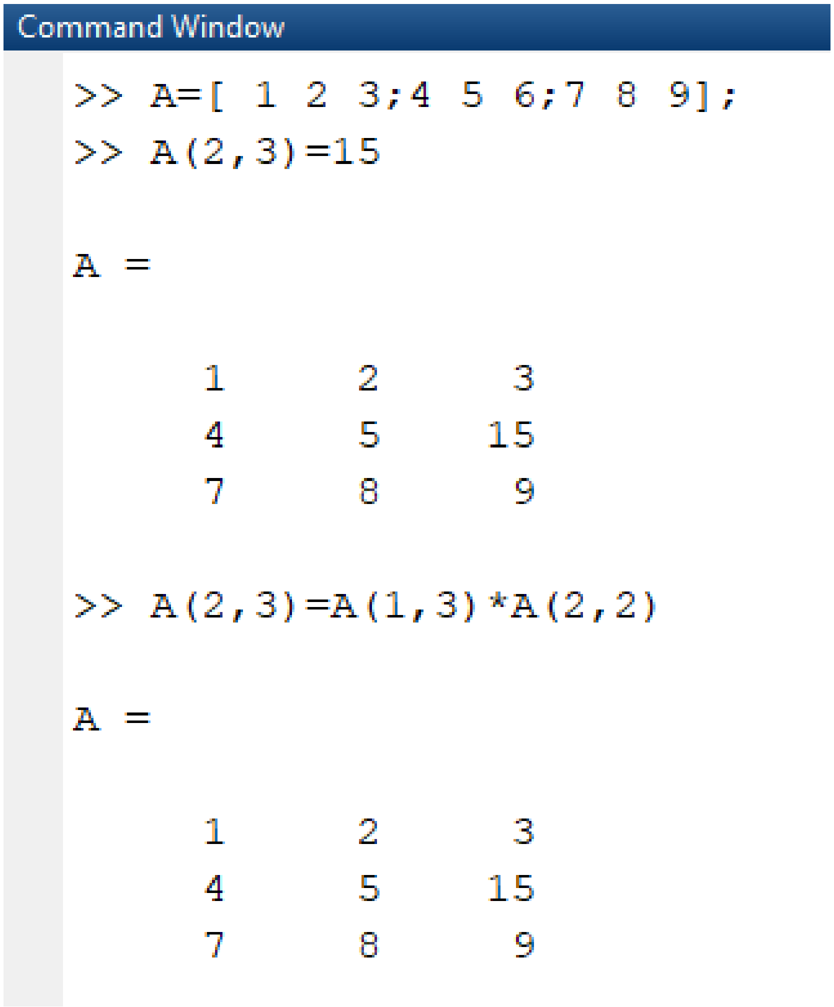


```
>> T3=[T' T2 G]

T3 =

    -1     4    -1     3     4     1     5     1     5
     3     5     4     5     6     4     5     4     5
     4     6     1     2     3     0     2     0     2
```



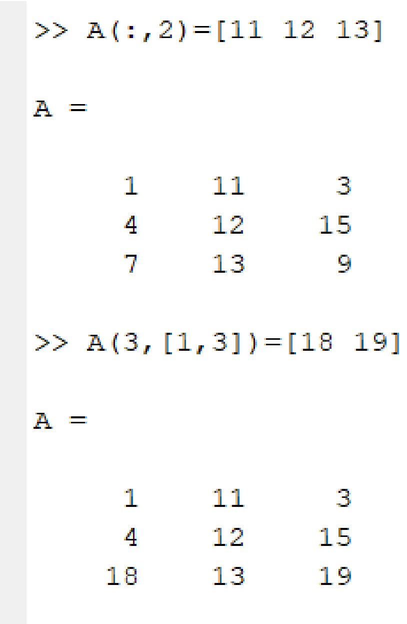
```
>> T4=[G',diag([5;6]);ones(3,2),T1]

T4 =

     1     4     0     5     0
     5     5     2     0     6
     1     1    -1     3     4
     1     1     4     5     6
     1     1     1     2     3
```

Example 2: -

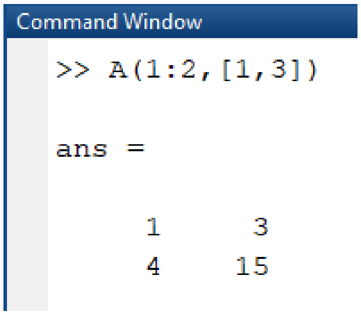


```
>> A=[ 1 2 3;4 5 6;7 8 9];
>> A(2,3)=15

A =

     1     2     3
     4     5    15
     7     8     9

>> A(2,3)=A(1,3)*A(2,2)

A =

     1     2     3
     4     5    15
     7     8     9
```

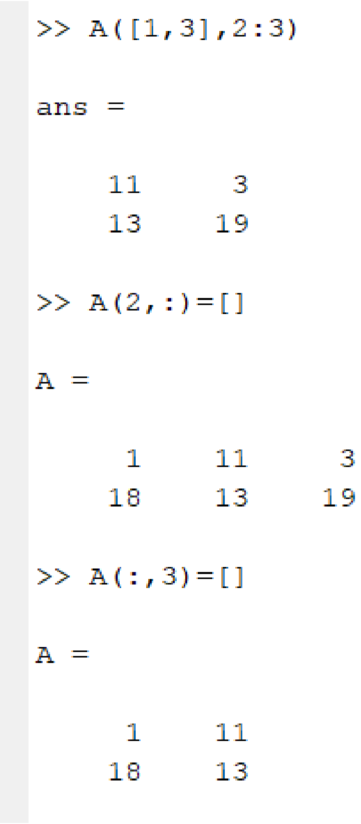
Change column 2 by v=[11 12 13]



```
>> A(:,2)=[11 12 13]

A =

     1    11     3
     4    12    15
     7    13     9

>> A(3,[1,3])=[18 19]

A =

     1    11     3
     4    12    15
    18    13    19
```

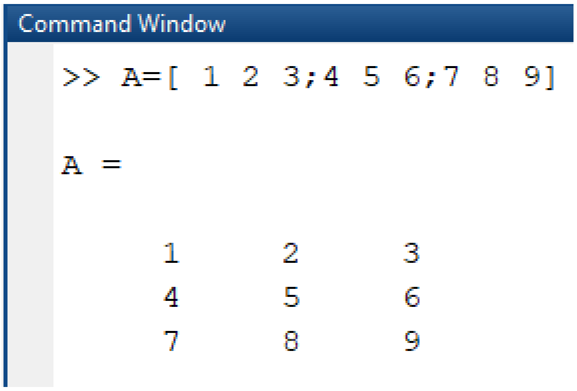


```
>> A(1:2,[1,3])

ans =

     1     3
     4    15
```



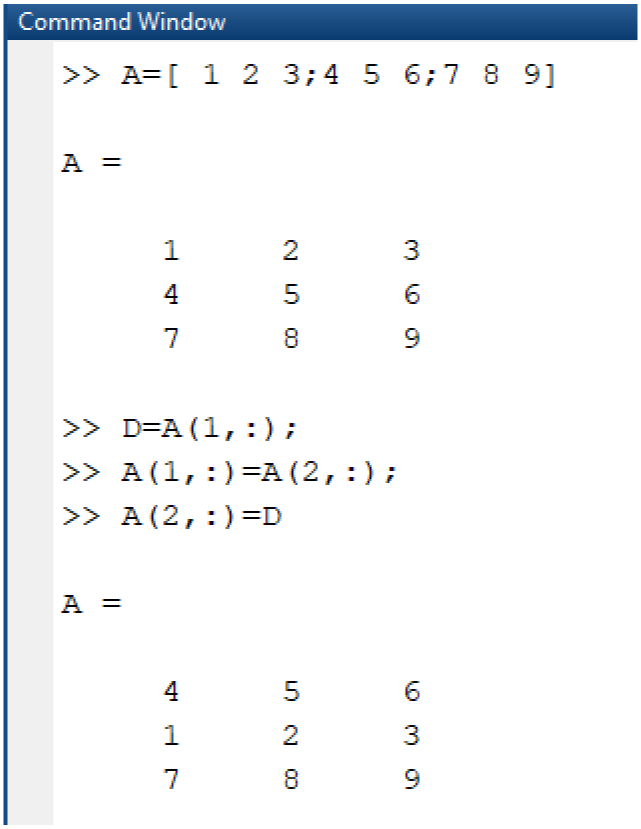
```
>> A([1,3],2:3)

ans =

    11     3
    13    19

>> A(2,:)=[]

A =

     1    11     3
    18    13    19

>> A(:,3)=[]

A =

     1    11
    18    13
```

Example: -



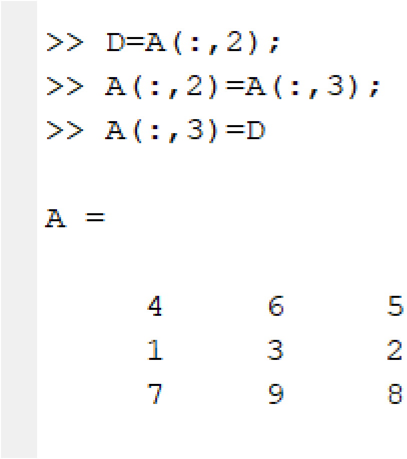
```
>> A=[ 1 2 3;4 5 6;7 8 9]

A =

     1     2     3
     4     5     6
     7     8     9
```

Swap R1 and R2



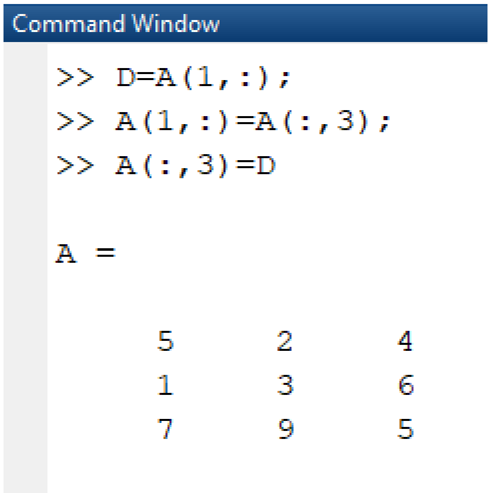
```
>> A=[ 1 2 3;4 5 6;7 8 9]

A =

     1     2     3
     4     5     6
     7     8     9

>> D=A(1,:);
>> A(1,:)=A(2,:);
>> A(2,:)=D

A =

     4     5     6
     1     2     3
     7     8     9
```

Change C2 with C3



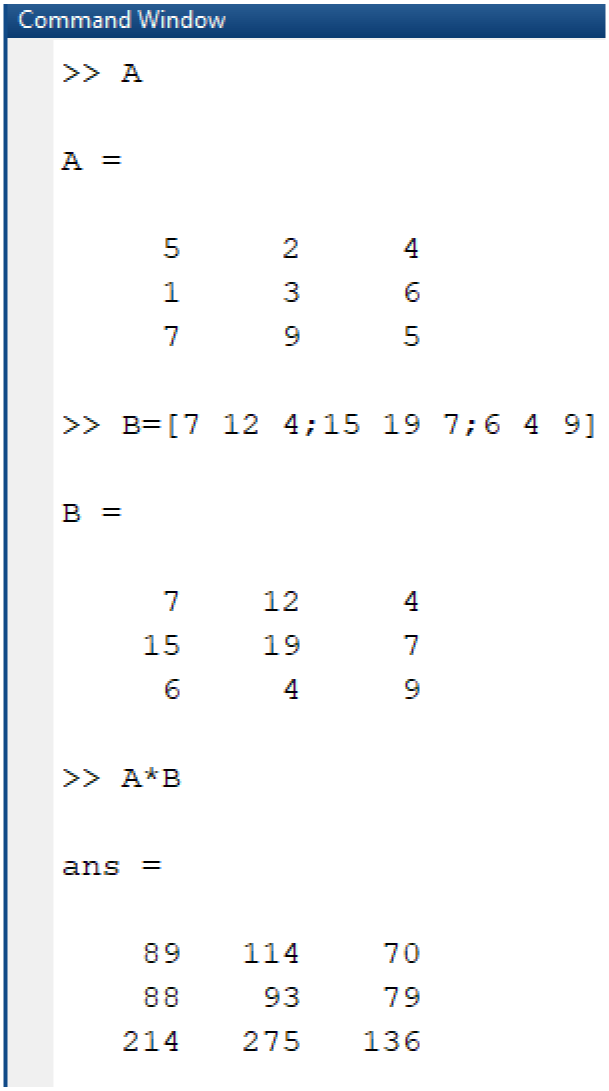
```
>> D=A(:,2);
>> A(:,2)=A(:,3);
>> A(:,3)=D

A =

     4     6     5
     1     3     2
     7     9     8
```

Swap R1 and R3

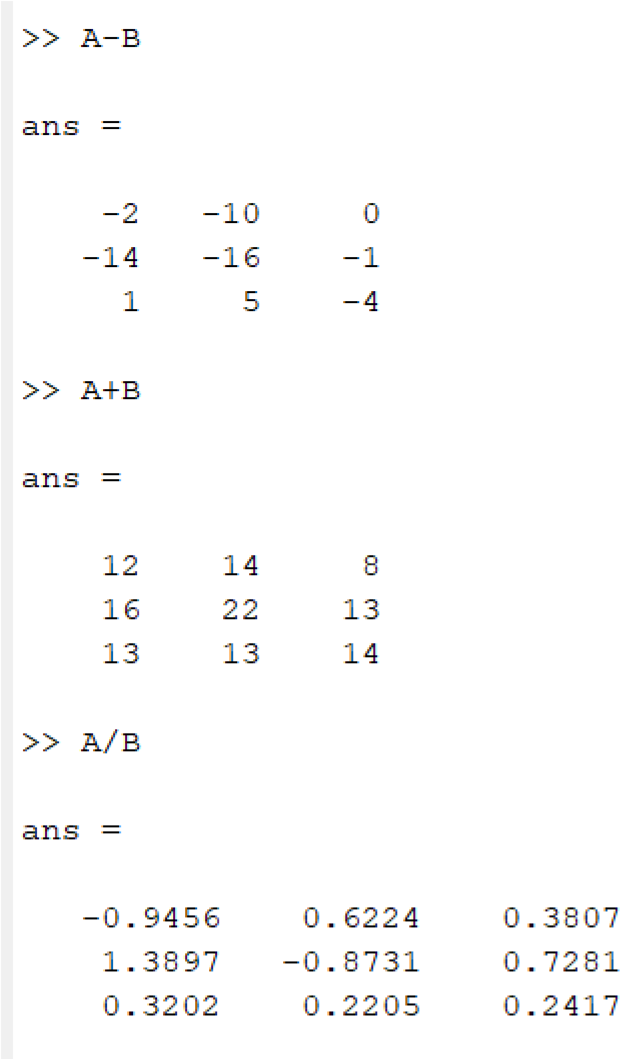


```
>> D=A(1,:);
>> A(1,:)=A(:,3);
>> A(:,3)=D

A =

     5     2     4
     1     3     6
     7     9     5
```

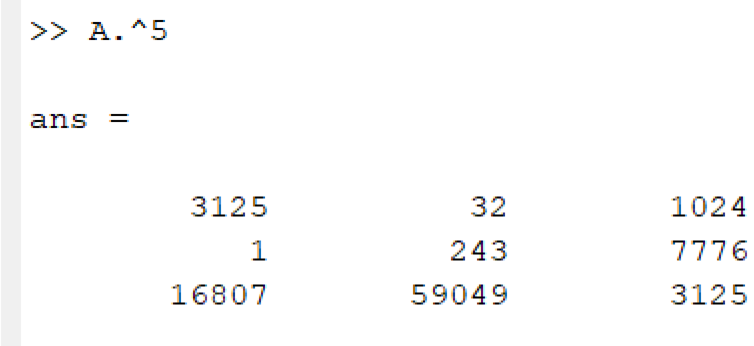
Matrices Arithmetic



```
>> A

A =

     5     2     4
     1     3     6
     7     9     5

>> B=[7 12 4;15 19 7;6 4 9]

B =

     7    12     4
    15    19     7
     6     4     9

>> A*B

ans =

    89   114    70
    88    93    79
   214   275   136
```



```
>> A-B

ans =

    -2   -10     0
   -14   -16    -1
     1     5    -4

>> A+B

ans =

    12    14     8
    16    22    13
    13    13    14

>> A/B

ans =

   -0.9456    0.6224    0.3807
    1.3897   -0.8731    0.7281
    0.3202    0.2205    0.2417
```



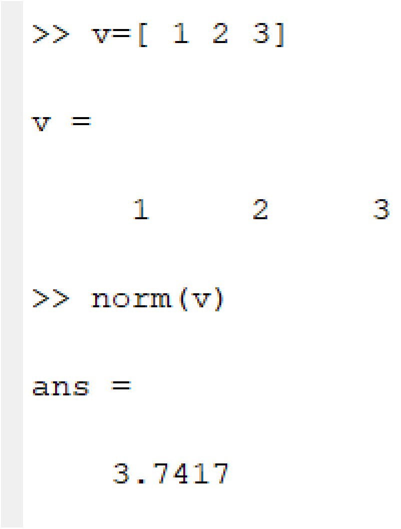
```
>> A.^5

ans =

        3125          32        1024
           1         243        7776
       16807       59049        3125
```

Euclidean Norm

The Euclidean norm (or 2-norm) of a vector v that has N elements is defined by

$$\|v\| = \sqrt{\sum_{k=1}^{N} |v_k|^2} \; .$$

\

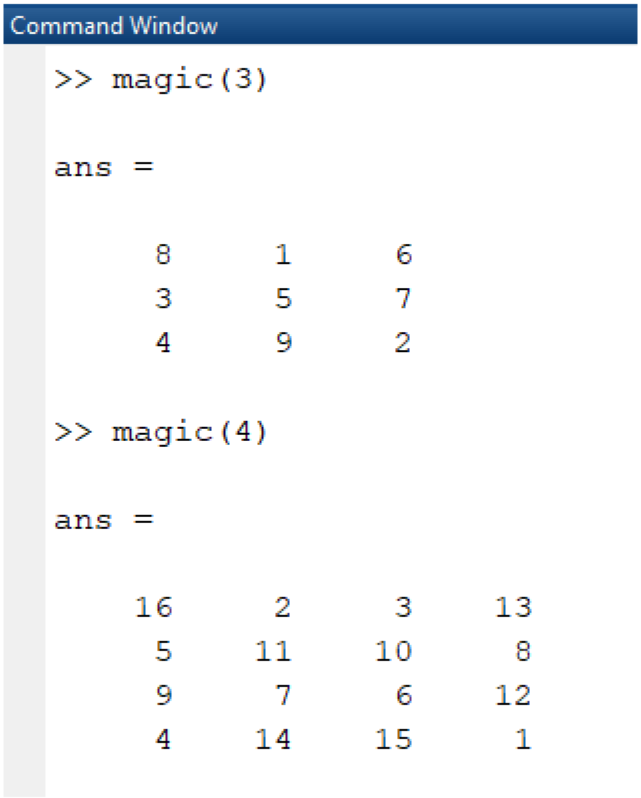


```
>> v=[ 1 2 3]

v =

     1     2     3

>> norm(v)

ans =

    3.7417
```

Magic Function

Matlab has build in function that create magic sequence of almost any size

>> magic(n) → build a square matrix of size $n * n$ and that elements between 0 –> n^2



```
>> magic(3)

ans =

     8     1     6
     3     5     7
     4     9     2

>> magic(4)

ans =

    16     2     3    13
     5    11    10     8
     9     7     6    12
     4    14    15     1
```