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I am truly grateful to all of you for your contributions, which have made this mathematics lab course a truly enriching and fulfilling experience for me.

Sincerely,

Nishan Pradhan

TABLE OF CONTENT

MATHEMATICA

MATLAB

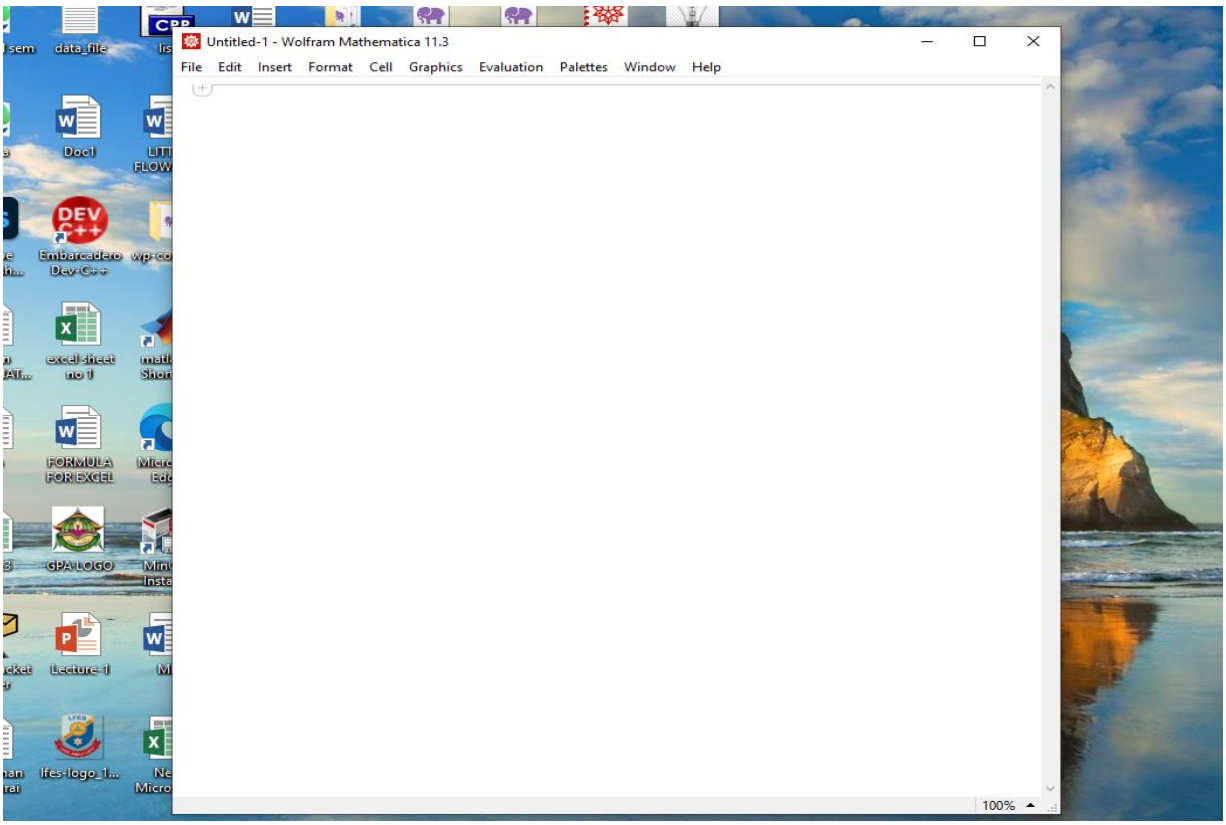
MATHEMATICA

INTRODUCTION

Wolfram Mathematica is a software system that features pre-built libraries for multiple technical computing applications, including machine learning, statistical analysis, symbol manipulation, data handling, network analysis, time series analysis, optimization, and plotting functions. Additionally, it supports various types of data, enables algorithm implementation, facilitates the creation of user interfaces, and offers interfacing capabilities with programs developed in other programming languages. Stephen Wolfram conceptualized the software, and it is currently developed by Wolfram Research, headquartered in Campaign, Illinois.

How to open Mathematica: -

1. Firstly, Go to search bar,
2. Then, Type wolfram Mathematica and click to open,
3. Now the Mathematica will be opened.



ADVANTAGE OF WOLFRAM MATHEMATICA:

1. Wolfram Mathematica applies an intelligent automation in every part of the system
   From algorithm to plot layout and user interface design.
2. We can get reliable, high quality result without needing algorithm expertise.
3. Wolfram Mathematica has efficient and versatile feature for visualization problems.
4. Wolfram Mathematica is great in solving of any kind of mathematical problem. For instance, PDEs.
5. Wolfram Mathematica is great in AI and KI data analysis.

DISADVANTAGE OF WOLFRAM MATHEMATICA:

1. Mathematica is not very well at import and export. Too many formats of interest are missing and there is much knowledge hidden behind for a better efficiency.
2. It is not easy to use this tool as it has its own scripting language and learning that is not straight forward.
3. Needs a lot of learning. Wolfram has a very vast language. It takes a lot of time to understand and learn it.

USE OF WOLFRAM MATHEMATICA:

1. For drawing parabola, ellipse, circle etc.
2. For finding determinant, adjoint, product etc. of matrix.
3. For finding the scientific values and solve geometrical problems.

RELATION, FUNCTION AND GRAPH

OBJECTIVE 1:

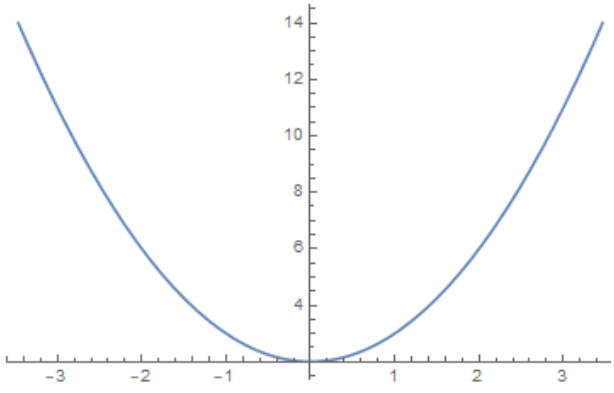
Let f: R→R define by f(x) = x+5 and g: R→R define by g(x) = x^2-3, then find (fog)(x) and gof(x).

WORKING EXPRESSION: - A relation is set of ordered pairs, where each pair consists of an input value and on output value. It is often denoted by R. If (x, y) is an ordered pair in the relation R, we write x R y, which means that x is related to y by R. A function is a special kind of relation in which each input value is related to exactly one output value. It is often denoted by f. If (x,y) is an ordered pair in the function f, we write f(x) = y, which means that the input value x is mapped to the output value y by the function f.

Calculation and Output: -

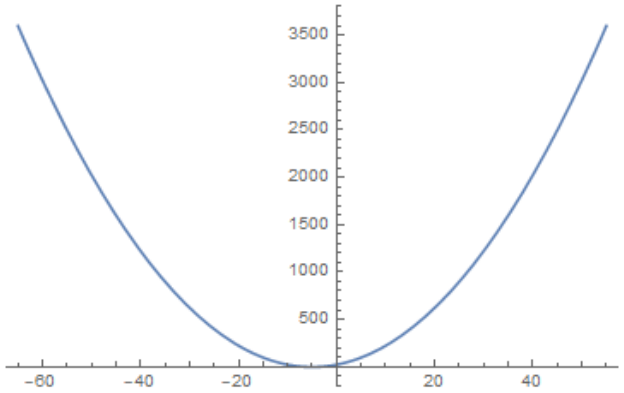
```
In[1]:= f[x_] := x + 5
        g[x_] := x^2 - 3
        f[g[x]]
Out[3]= 2 + x^2
In[4]:= Plot[2 + x^2, {x, -3.4641, 3.4641}]
```

Out[4]=




```
In[5]:= g[f[x]]
Out[5]= -3 + (5 + x)^2
In[6]:= Plot[-3 + (5 + x)^2, {x, -65., 55.}]
```

Out[6]=



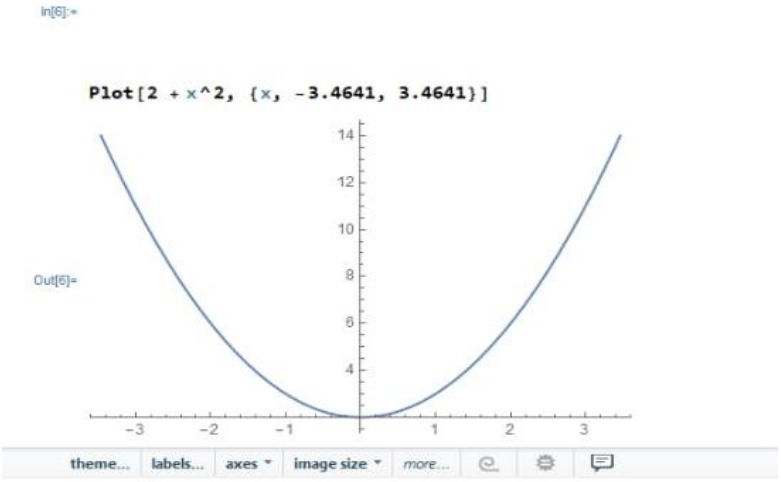
Conclusion: the output of (fog)(x) is 2 + x^2 and gof(x) is 3 + $(5+x)^2$.

SOME GRAPHS

OBJECTIVE 2:

Draw the graph of $y = 2+x^2$ ($-3.4641 \leq x \leq 3.4641$)

Calculation and output:

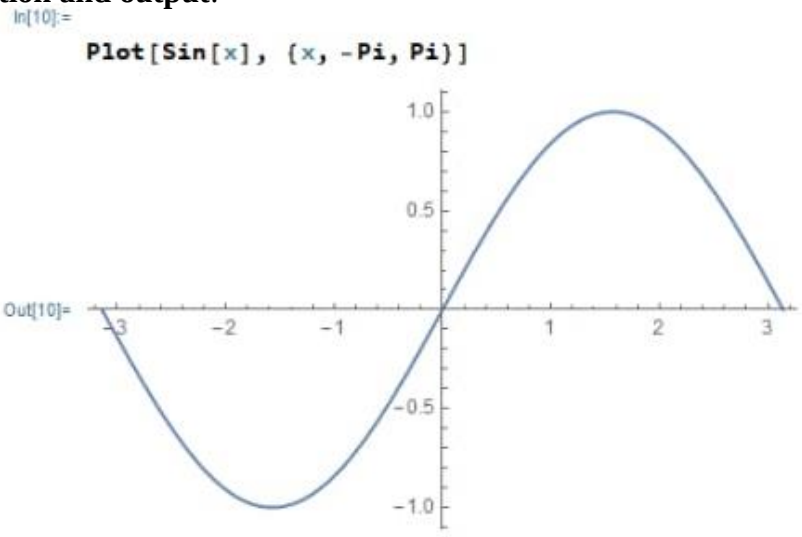


Conclusion: The graph has been plotted.

OBJECTIVE 3:

Draw the graph of y= sin(x) ($-\pi \leq x \leq \pi$).

Calculation and output:

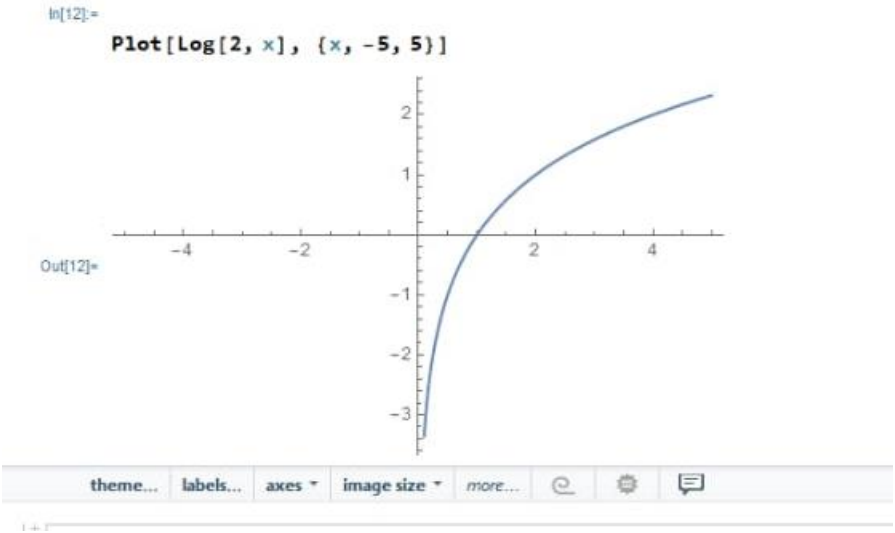


Conclusion: The graph has been plotted.

OBJECTIVE 4:

Draw the graph of y = Log (2, x) (-5 ≤ x ≤ 5).

Calculation and output:



Conclusion: The graph has been plotted.

MATLAB

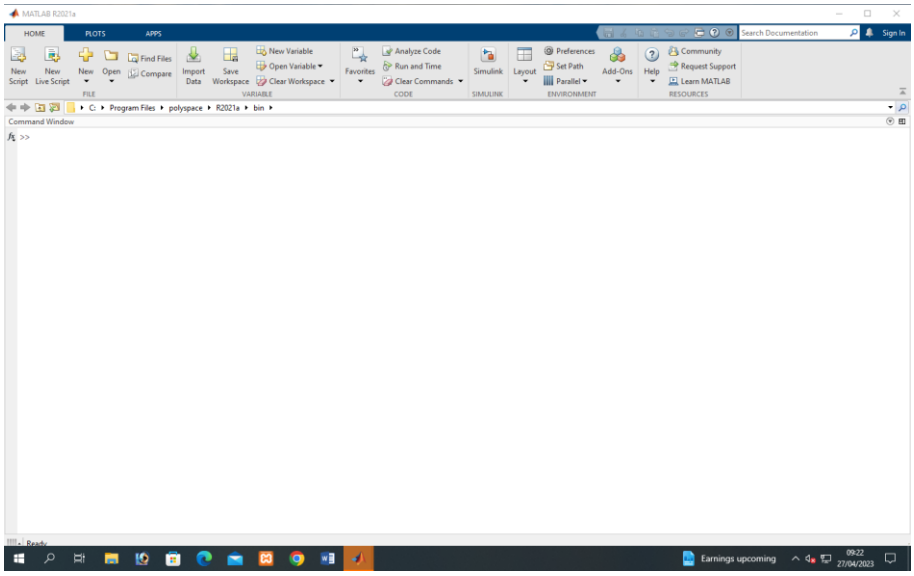
INTRODUCTION

MATLAB is a programming platform that caters to the needs of engineers and scientists for analyzing and designing systems and products that have the potential to transform our world. At the core of MATLAB lies its language, which is matrix-based and enables the seamless expression of computational mathematics.

How to open MATLAB

1. Click windows key + R. the run interface will be opened,
2. Click on the search bar and type MATLAB,
3. Press “OK”. The MATLAB will open.

Interface of MATLAB after opened.



ADVANTAGE OF MATLAB:

1. Easy to use.
2. Documentation for every command.
3. Develop application with graphic user interface.
4. You can also plot 2D and 3D plots and animations too in MATLAB.
5. You can also write your own function and save it, so that it can be used later as a built-in function.

DISADVANTAGE OF MATLAB:

1. The speed of MATLAB is slow, you can overcome this by properly structuring the MATLAB program.
2. It is not open-source structure.

APPLICATION OF MATLAB:

1. Math and Computation.
2. Algorithm development.
3. Modelling, simulation, and prototyping.
4. Data analysis, exploration, and visualization.
5. Scientific and Engineering graphics.
6. Application development, including GUI building.

COMMANDS IN MATLAB:

Command	Description
clc	Clears the command window.
rand	Generates random numbers from a uniform distribution.
eye	Generates an identity matrix.
zeros	Generates a matrix of zeros.
ones	Generates a matrix of ones.
diag	Extracts the diagonal elements of a matrix or creates a diagonal matrix.
size	Returns the dimensions of a matrix.
sum	Returns the sum of the elements in a matrix.
prod	Returns the product of the elements in a matrix.
sort	Sorts the elements in a matrix.
transpose or '	Transposes a matrix.
inv	Computes the inverse of a matrix.

OBJECTIVE 1:

Construct 3 × 3 matrix on zeros.

WORKING EXPRESSION: Matrices can be created using square brackets to separate rows and semicolons to separate columns. Matrix elements can be accessed using row and column indices, and various arithmetic operations can be performed on matrices such as addition, subtraction, multiplication, and division. MATLAB also provides a variety of built-in functions for working with matrices, such as finding the transpose, inverse, eigenvalues, and eigenvectors.

Calculation and output:

```
>> zeros(3,3)

ans =

     0     0     0
     0     0     0
     0     0     0

>>
```

Calculation and output: It are possible to create a 3x3 matrix filled with zeros.

OJECTIVE 2:

Construct an identity matrix.

Calculation and output:

```
>> eye (4,4)

ans =

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

Conclusion: It is possible to create a 4x4 matrix.

OBJECTIE 3:

To construct rectangular matrix:

Calculation and output:

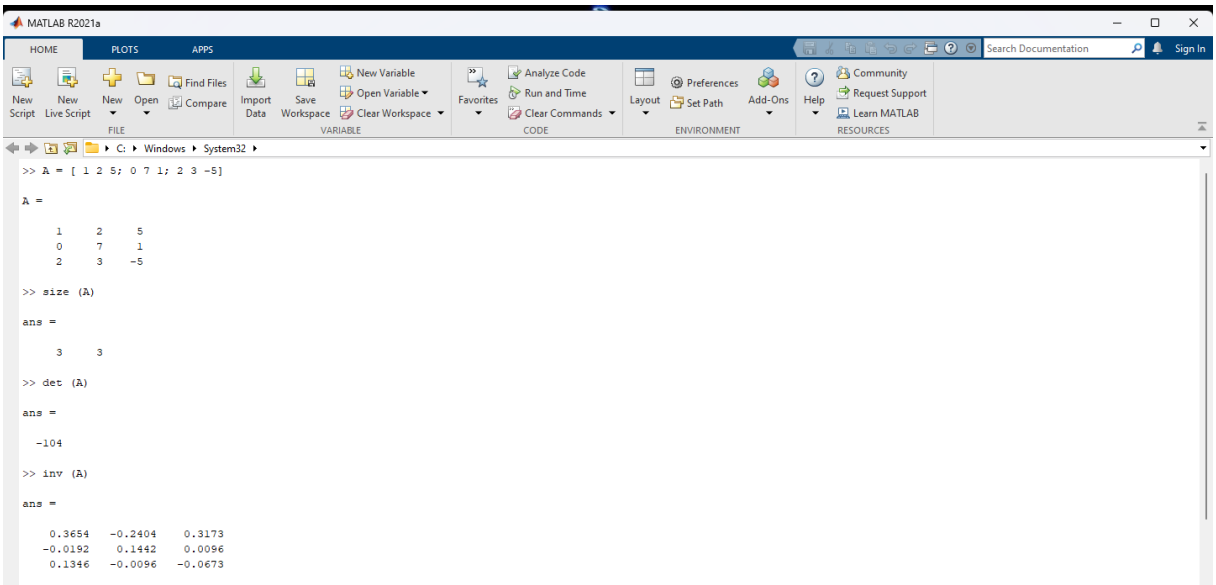
```
>> B = [1,2,3,4,5;6,7,8,9,10;11,12,13,14,15;2,5,6,7,8;1,2,4,5,6]

B =

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

Conclusion: It is possible to create a rectangular matrix with desired elements.

OBJECTIVE 4:

Find the inverse of matrix.

Calculation and output.

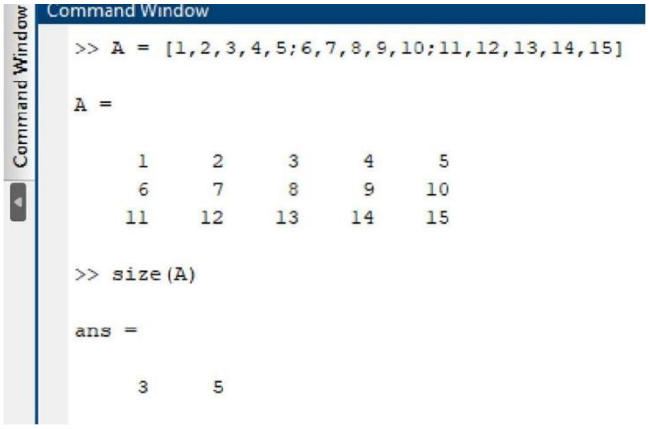


Conclusion: Thus, the inverse of matrix was found. $\begin{pmatrix} 0.3654 & -0.2404 & 0.3173 \\ -0.0192 & 0.1442 & 0.0096 \\ 0.1346 & -0.0096 & -0.0673 \end{pmatrix}$

OJBECTIVE 5:

To find the size of A input matrix.

Calculation and output



Conclusion: It is possible to find the size of a matrix.

OBJECTIVE 6:

To find $A^T + B^T$ and $A^T - B$

Calculation and output:

```
>> A'+B'

ans =

     2    12    12     3     6
     4    14    14     7     8
     6    16    16     9    11
     8    18    18    11    13
    10    10    20    13    15

>> A'-B

ans =

     0     4    -2    -3     0
    -4     0    -6    -7    -4
    -8    -4   -10   -11    -8
     2     4    -2    -3     0
     4    -2     1     0     3
```

Conclusion: It is possible to find $A^T + B^T$ and $A^T - B$ using MATLAB.

OBJECTIVE 7:

To verify $AA^{-1} = A^{-1}A = I$ and its rank.

Calculation and Output:

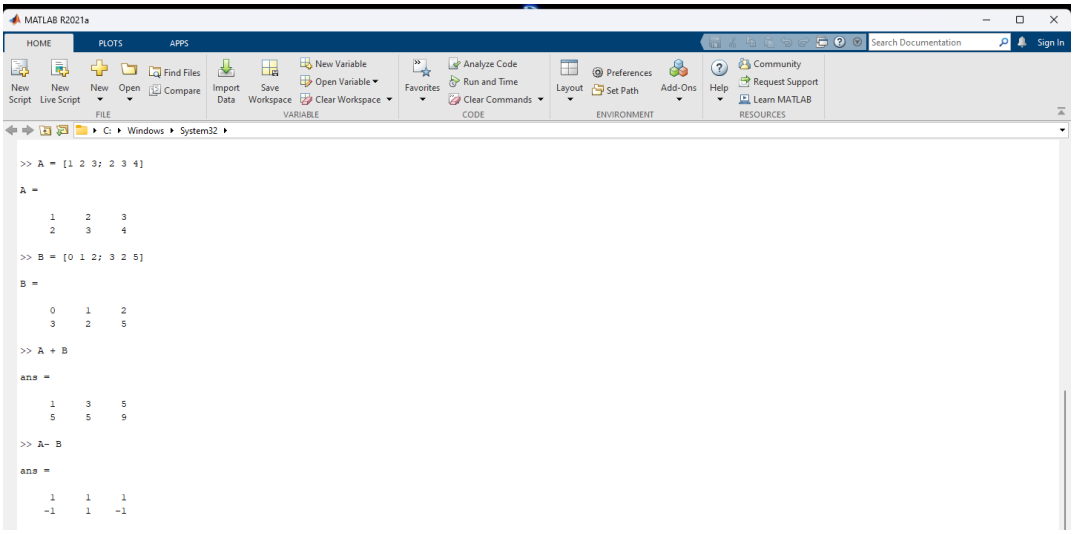
```
>> A * inv (A)

ans =

     1     0     0
     0     1     0
     0     0     1

>> inv (A)* A

ans =

    1.0000    0.0000         0
         0    1.0000         0
         0         0    1.0000

>> rank (A)

ans =

     3
```

Conclusion: Hence, it is verified $AA^{-1} = A^{-1}A = I$ and its rank.

OBJECTIVE 8:

Find the sum and differences of two matrices.

Calculation and Output:



Conclusion: Hence, the sum and differences of two matrix is found.

OBJECTIVE 9:

To find the determinant and adjoint of the given matrix.

Calculation and output.

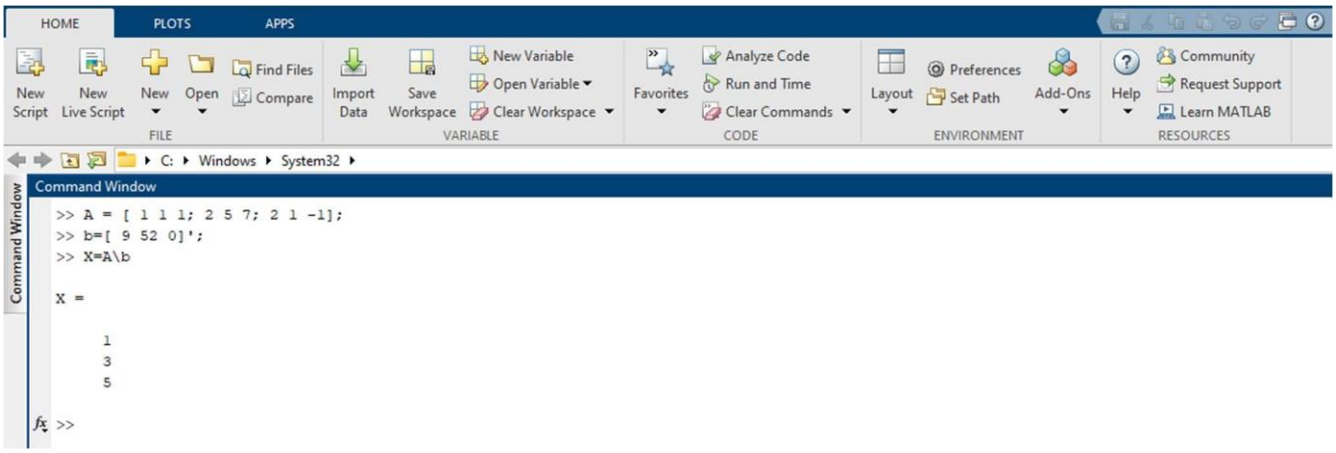
```
>> % Find the value of determinants by expandng along row or column.
>> A = [1 2 3; 2 4 1; 3 2 9 ]

A =

     1     2     3
     2     4     1
     3     2     9

>> det (A)

ans =

   -20

>> % Find the adjoint of the given matrix.
>> A= [1 2 3; 0 7 1; 2 5 4]

A =

     1     2     3
     0     7     1
     2     5     4

>> % to find adjoint we use the given formula:
>> det (A) * inv (A)

ans =

   23.0000    7.0000  -19.0000
    2.0000   -2.0000   -1.0000
  -14.0000   -1.0000    7.0000

fx >>
```

Conclusion: The determinant and adjoint of the given matrix was found using MATLAB.

OBJECTIVE 10:

If x + y + z = 9; 2x + 5y + 7z = 52, 2x + y – z = 0 and X = A \ B, solve for x where A, B is a matrix.

Calculation and output:



Conclusion: The value of x. was found to be [1 3 5] using MATLAB.

VECTORS

OBJECTIVE 11:

Find $[\vec{a}\ \vec{b}\ \vec{c}\ ]$ and $\vec{a} \times (\vec{b} \times \vec{c}\ )$: $\vec{a}= 3\vec{\imath} + \vec{\jmath} + \vec{k}$, $\vec{b}= \vec{\imath} + \vec{\jmath} + \vec{k}$ and $\vec{c}= 2\vec{\jmath} - 3\vec{k}$

WORKING EXPRESSION: The scalar triple product is defined as the scalar obtained by taking the dot product of the vector obtained from the cross product of two given vectors with a third vector. Mathematically, it can be written as: (a x b).c

The vector triple product is defined as the vector obtained from taking the cross product of two given vectors and then taking the dot product of the result with a third vector. Mathematically, it can be written as: a x (b x c)

Calculation and Output:

```
>> %Find [a b c] and [a. b*c]%
>> %a=3i+j+k, b=i+j+k, and c= 2j-3k.%
>> a=[3,1,1]

a =

     3     1     1

>> b=[1,1,1]

b =

     1     1     1

>> c=[0,2,-3]

c =

     0     2    -3

>> dot(a,cross(b,c))

ans =

   -10

>> cross(a,cross(b,c))

ans =

    -1   -11    14
```

Conclusion: Therefore, we found that $[\vec{a}\ \vec{b}\ \vec{c}\ ]$= -10 and $\vec{a} \times (\vec{b} \times \vec{c}\ )$=(-1, -11, 14).

OBJECTIVE 12:

If $\vec{a}$ = (1, 2, 3), $\vec{b}$ = (2, 3, 4), find the dot product of a and b.

WORKING EXPRESSION: In MATLAB, the dot product or inner dot product is like a matrix multiplication. That is, we multiply a row vector by a column vector. The number of elements must be same in both vectors. We can do this product by using the dot function in MATLAB.

Calculation and Output:

```
Command Window
>> % Find the dot product of a and b%
>> a=[1, 2, 3]

a =

     1     2     3

>> b=[2, 3, 4]

b =

     2     3     4

>> dot(a,b)

ans =

    20
```

Conclusion: The dot product of $\vec{a}$ = (1, 2, 3), $\vec{b}$ = (2, 3, 4) was found to be 20 using MATLAB.

OBJECTIVE 13:

To find the dot and cross triple product of a and b. where $\vec{a}$ = $\vec{}$ + 4$\vec{}$ 7$\vec{k}$, $\vec{b}$ = 2$\vec{}$ - $\vec{}$ + 4$\vec{k}$, and $\vec{c}$= -9$\vec{}$ + 18$\vec{k}$.

Calculation and output:

```
>> a=[1, 4, -7]

a =

     1     4    -7

>> b=[2,-1,4]

b =

     2    -1     4

>> c=[0,-9,18]

c =

     0    -9    18

>> dot(a, cross(b,c))

ans =

     0

>> cross(a, cross(b,c))

ans =

  -324  -108  -108
```

Conclusion: The value of dot triple product is 0 and cross triple product is (-324, -108, 108).

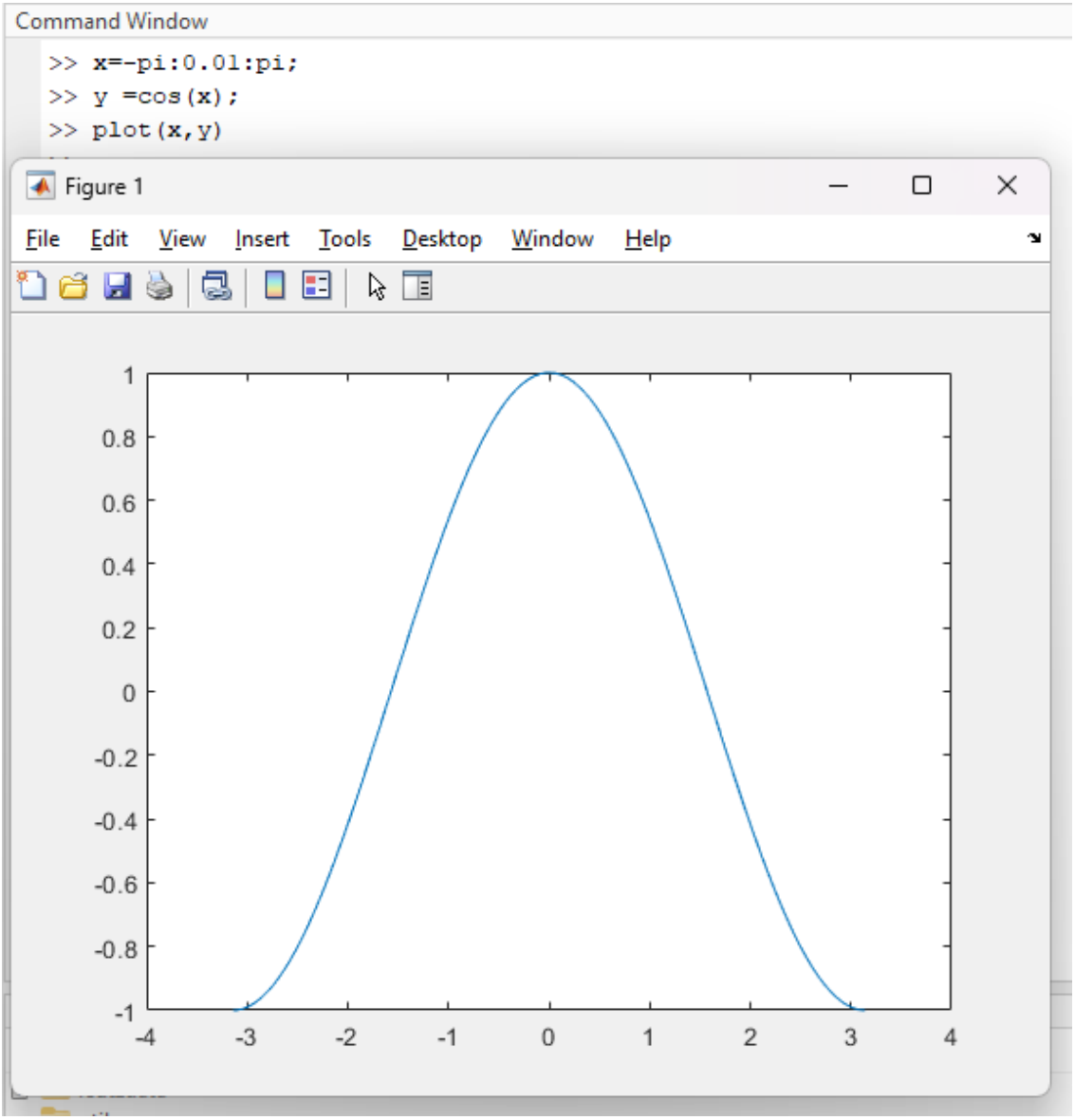
Vector plotting.

VECTOR PLOTTING

OBJECTIVE 14:

To obtain the graph of y = cos (x) from –π to π

Calculation and output:

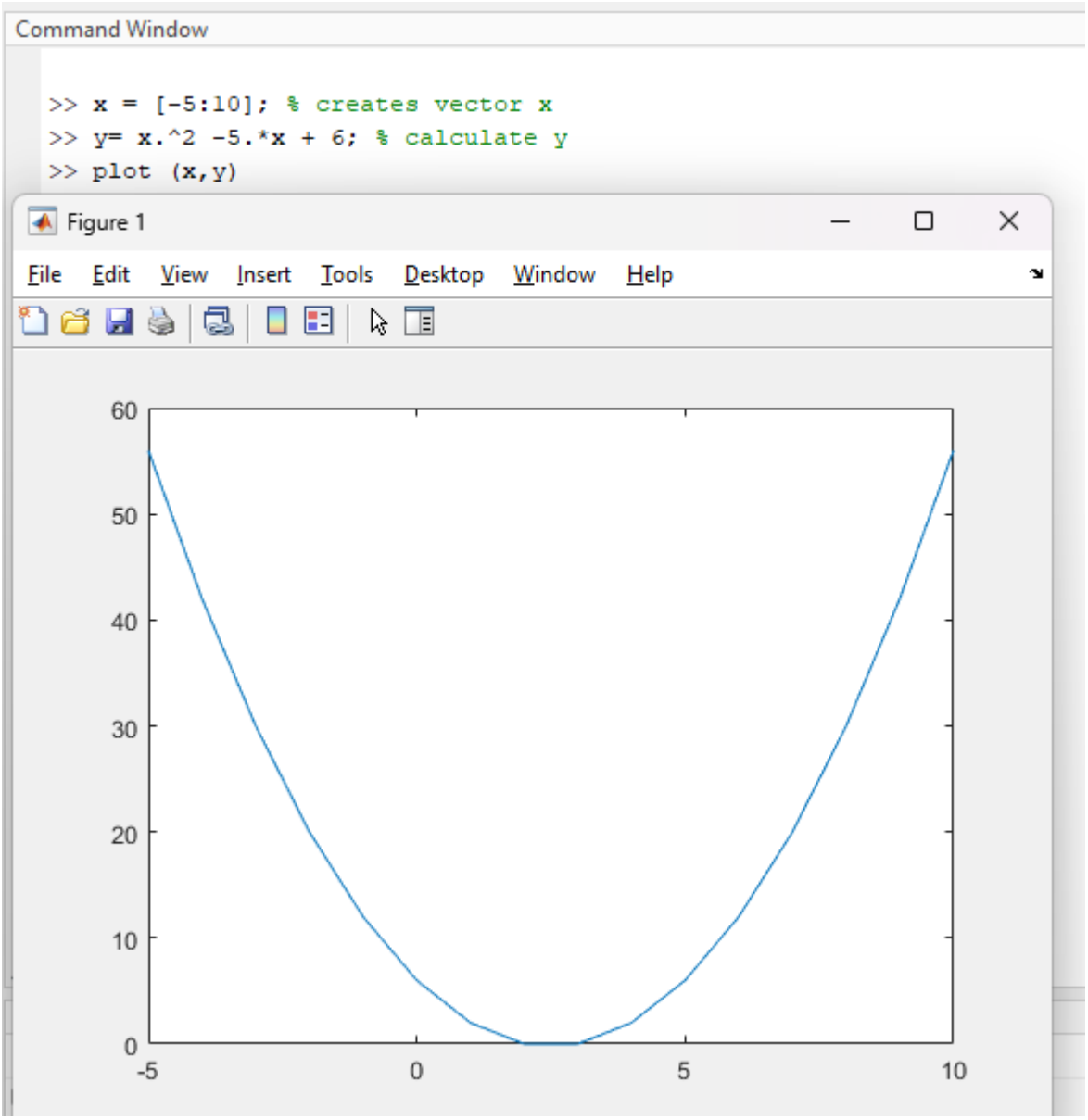


Conclusion: Hence, y = cos (x) from –π to π was plotted.

OBJECTIVE 15:

Plot the function $y = x^2 – 5x + 6$, where x € [-5, 10]

Calculation and output:



Conclusion: Hence, $y = x^2 – 5x + 6$, where x € [-5, 10] was plotted.