Practical of mathematics for computing

RAMANUJAN COLLEGE

UNIVERSITY OF DELHI

DSC 03: *MATHEMATICS FOR COMPUTING-1*

SEMESTER: 1

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Semester 1

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RADHIKA

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PRACTICAL -01

#find cofactors, determinant, adjoint, and inverse of a matrix.

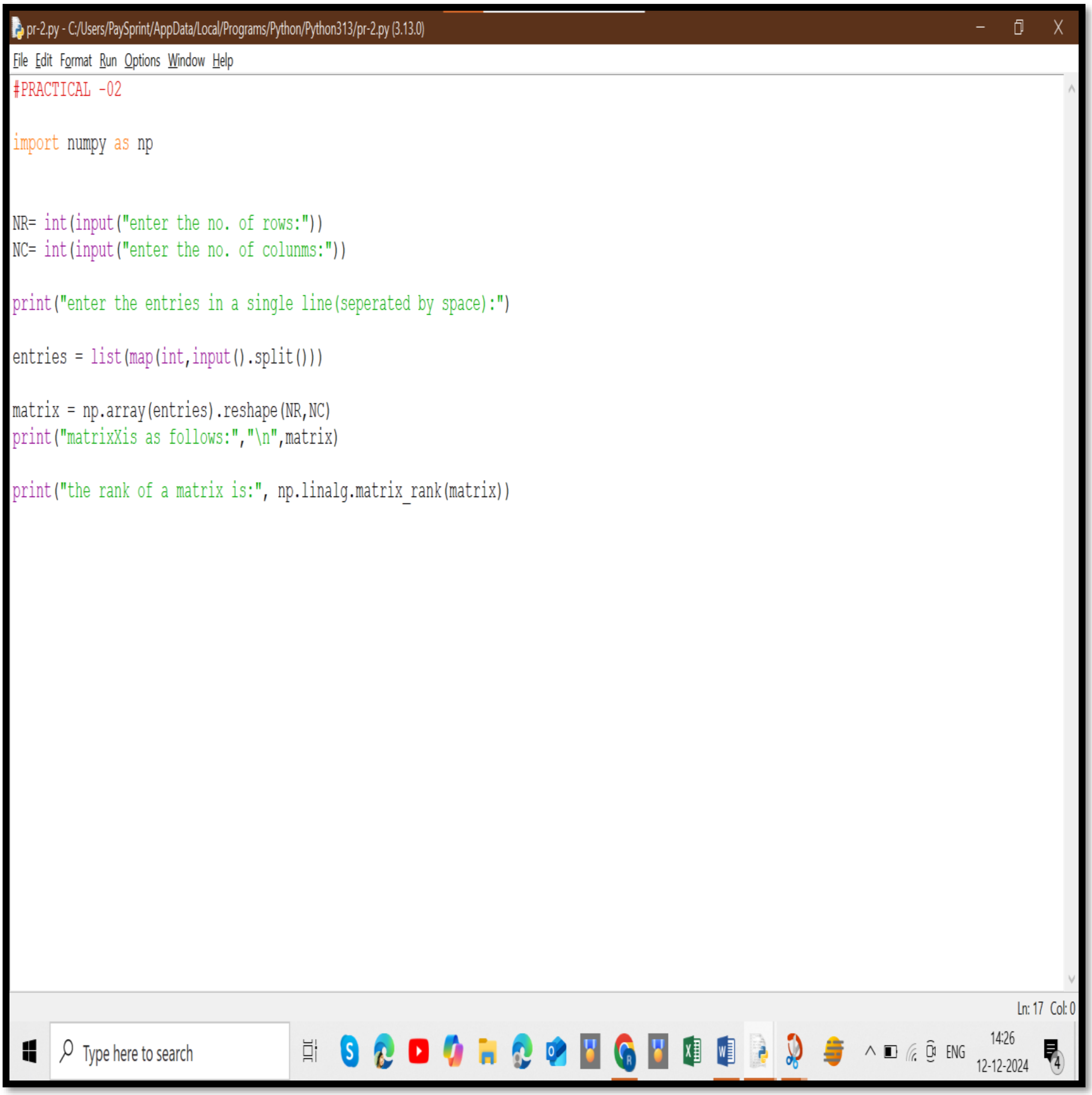
```python
import numpy as np

NR=int(input("Enter the no. of rows:"))

NC=int(input("Enter the no. of columns: "))

print("Enter the entries in a single line (separated by space):")

entries =list(map(int,input().split()))

A= np.array(entries).reshape(NR, NC)
print("matrix A is as follows:","\n",A)

A_Inverse=np.linalg.inv(A)

print("inverse of  A is" ,"\n",A_Inverse)

Transpose_of_A_Inverse=np.transpose(A_Inverse)

print("Transpose of A Inverse is","\n", Transpose_of_A_Inverse)

Determinant_of_A=np.linalg.det(A)

print("Determinant of A","\n", Determinant_of_A)


Cofactor_of_A=np.dot(Transpose_of_A_Inverse, Determinant_of_A)

print("The Cofactor of a Matrix is:", "\n",Cofactor_of_A)

Adjoint_of_A=np.transpose( Cofactor_of_A)

print("The Ajoint of a Matrix is:","\n",Adjoint_of_A)
```

OUTPUT

```
Python 3.13.0 (tags/v3.13.0:60403a5, Oct  7 2024, 09:38:07) [MSC v.1941 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:/Users/PaySprint/AppData/Local/Programs/Python/Python313/pr-01.py =
Enter the no. of rows:3
Enter the no. of columns: 3
Enter the entries in a single line (separated by space):
2 3 5 6 8 9 5 7 3
matrix A is as follows:
 [[2 3 5]
 [6 8 9]
 [5 7 3]]
inverse of  A is
 [[-3.          2.         -1.        ]
 [ 2.07692308 -1.46153846  0.92307692]
 [ 0.15384615  0.07692308 -0.15384615]]
Transpose of A Inverse is
 [[-3.          2.07692308  0.15384615]
 [ 2.         -1.46153846  0.07692308]
 [-1.          0.92307692 -0.15384615]]
Determinant of A
 13.000000000000005
The Cofactor of a Matrix is:
 [[-39.  27.   2.]
 [ 26. -19.   1.]
 [-13.  12.  -2.]]
The Ajoint of a Matrix is:
 [[-39.  26. -13.]
 [ 27. -19.  12.]
 [  2.   1.  -2.]]
>>>
```

PRACTICAL -02

#convert the matrix into echelon form and find its rank.



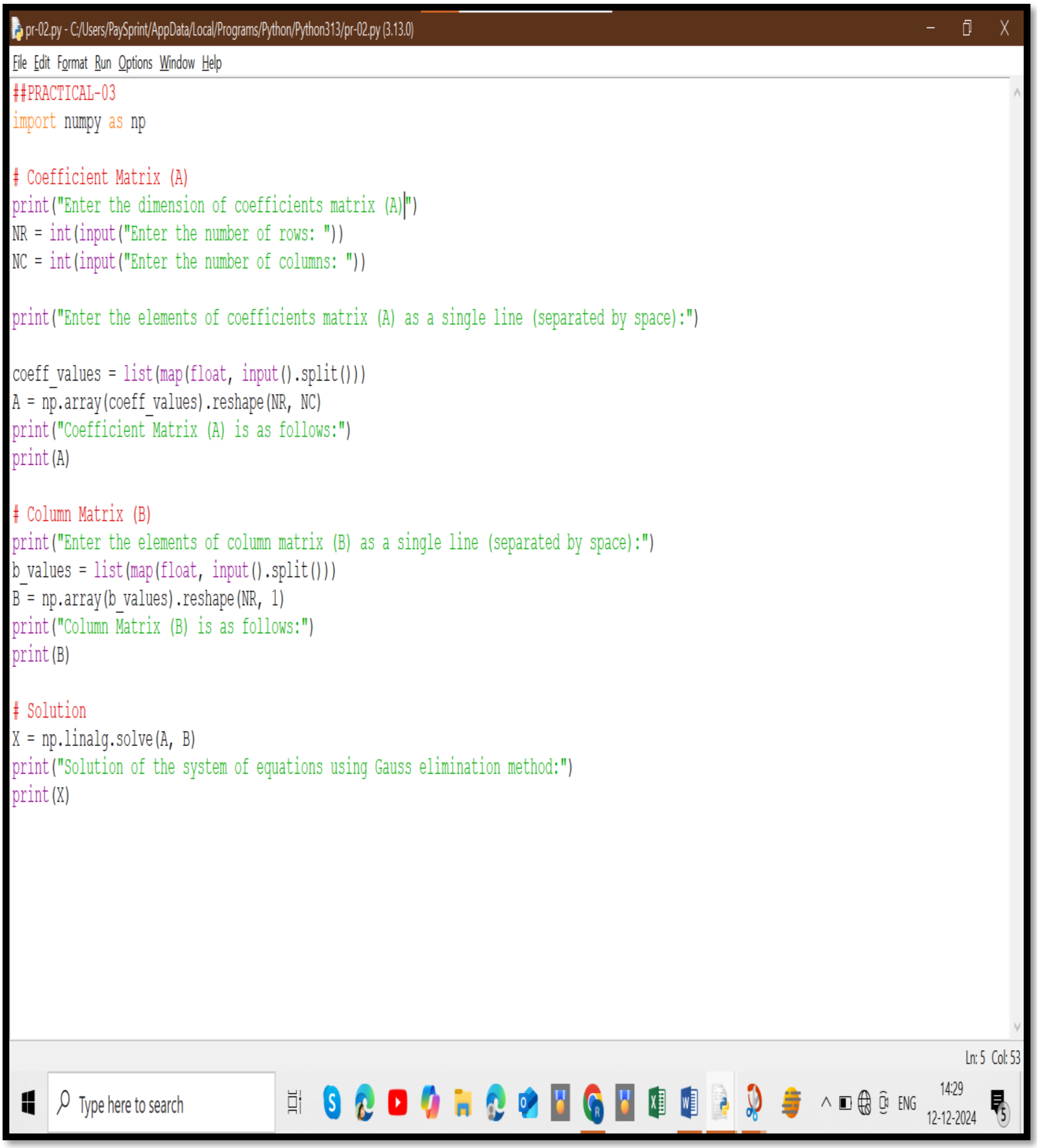

```
#PRACTICAL -02

import numpy as np


NR= int(input("enter the no. of rows:"))
NC= int(input("enter the no. of colunms:"))

print("enter the entries in a single line(seperated by space):")

entries = list(map(int,input().split()))

matrix = np.array(entries).reshape(NR,NC)
print("matrixXis as follows:","\n",matrix)

print("the rank of a matrix is:", np.linalg.matrix_rank(matrix))
```

OUTPUT

```
IDLE Shell 3.13.0
File Edit Shell Debug Options Window Help
Python 3.13.0 (tags/v3.13.0:60403a5, Oct  7 2024, 09:38:07) [MSC v.1941 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
== RESTART: C:\Users\PaySprint\AppData\Local\Programs\Python\Python313\pr-2.py =
enter the no. of rows:3
enter the no. of colunms:3
enter the entries in a single line(seperated by space):
5 7 9 0 6 4 8 9 3
matrix X is as follows:
 [[5 7 9]
 [0 6 4]
 [8 9 3]]
the rank of a matrix is: 3
>>>
Ln: 14 Col: 0
```

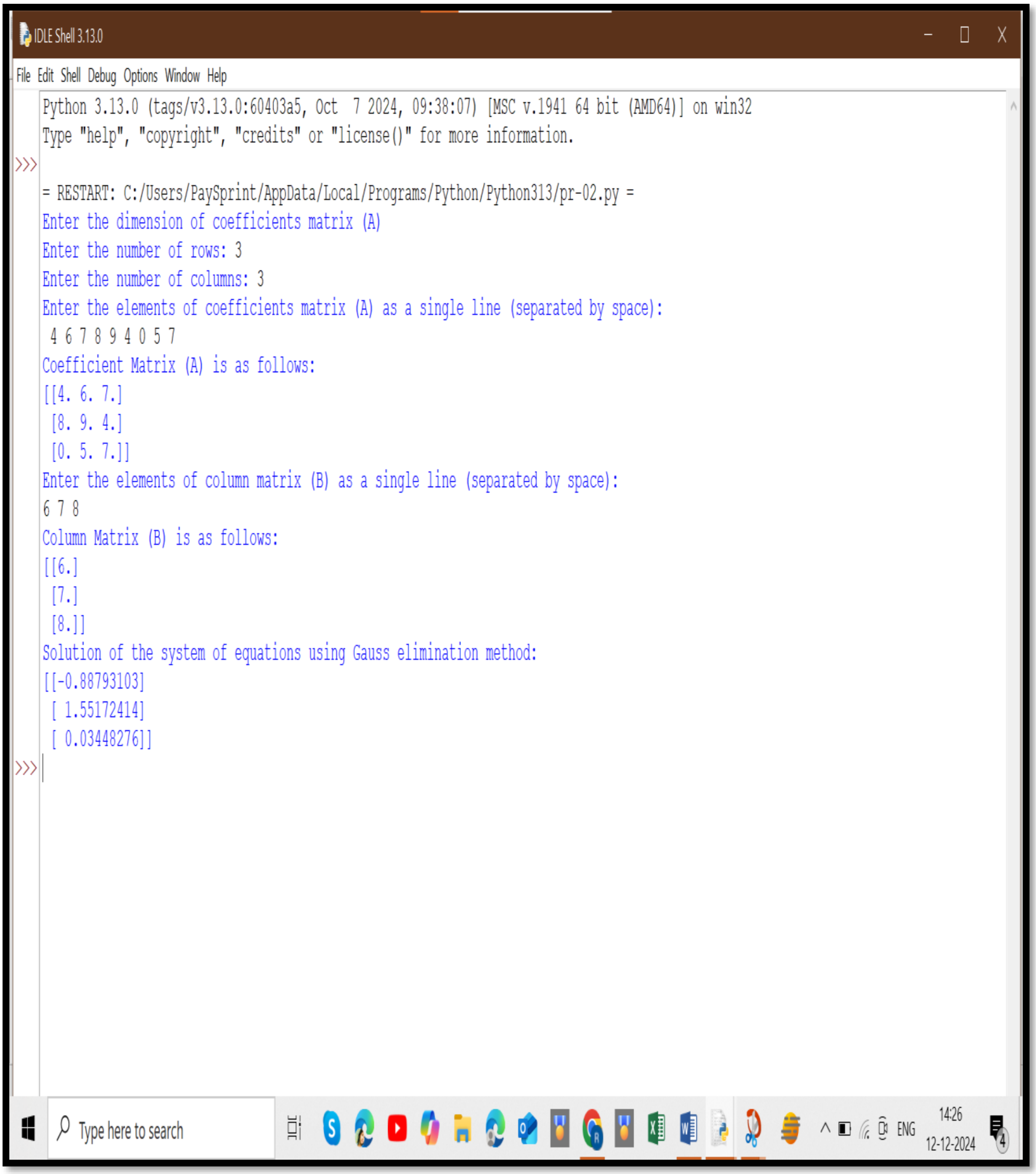
PRACTICAL -03

solve a system of equations using gauss elimination method.




```python
##PRACTICAL-03
import numpy as np

# Coefficient Matrix (A)
print("Enter the dimension of coefficients matrix (A)")
NR = int(input("Enter the number of rows: "))
NC = int(input("Enter the number of columns: "))

print("Enter the elements of coefficients matrix (A) as a single line (separated by space):")

coeff_values = list(map(float, input().split()))
A = np.array(coeff_values).reshape(NR, NC)
print("Coefficient Matrix (A) is as follows:")
print(A)

# Column Matrix (B)
print("Enter the elements of column matrix (B) as a single line (separated by space):")
b_values = list(map(float, input().split()))
B = np.array(b_values).reshape(NR, 1)
print("Column Matrix (B) is as follows:")
print(B)

# Solution
X = np.linalg.solve(A, B)
print("Solution of the system of equations using Gauss elimination method:")
print(X)
```

OUTPUT


IDLE Shell 3.13.0
File Edit Shell Debug Options Window Help
Python 3.13.0 (tags/v3.13.0:60403a5, Oct 7 2024, 09:38:07) [MSC v.1941 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:/Users/PaySprint/AppData/Local/Programs/Python/Python313/pr-02.py =
Enter the dimension of coefficients matrix (A)
Enter the number of rows: 3
Enter the number of columns: 3
Enter the elements of coefficients matrix (A) as a single line (separated by space):
4 6 7 8 9 4 0 5 7
Coefficient Matrix (A) is as follows:
[[4. 6. 7.]
[8. 9. 4.]
[0. 5. 7.]]
Enter the elements of column matrix (B) as a single line (separated by space):
6 7 8
Column Matrix (B) is as follows:
[[6.]
[7.]
[8.]]
Solution of the system of equations using Gauss elimination method:
[[-0.88793103]
[1.55172414]
[0.03448276]]
>>>
Type here to search
ENG
14:26
12-12-2024

PRACTICAL -04

solve a system of equations using gauss Jordan method.

```python
#PRACTICAL-04
import numpy as np

# Coefficient Matrix (A)
print("Enter the dimension of coefficients matrix (A)")
NR = int(input("Enter the number of rows: "))
NC = int(input("Enter the number of columns: "))

print("Enter the elements of coefficients matrix (A) as a single line (separated by space):")

coefficient_entries = list(map(float, input().split()))
coefficient_matrix = np.array(coefficient_entries).reshape(NR, NC)
print("Coefficient Matrix (A) is as follows:\n",coefficient_matrix,"\n")

# Column Matrix (B)
print("Enter the elements of column matrix (B) as a single line (separated by space):")
column_entries = list(map(float, input().split()))
column_matrix = np.array(column_entries).reshape(NR, 1)
print("Column Matrix (B) is as follows:\n",column_matrix,"\n")

# Solution
inv_ofcoefficient_matrix = np.linalg.inv(coefficient_matrix)
solution_of_the_system_of_equations = np.matmul(coefficient_matrix,column_matrix)
print("Solution of the system of equations using Gauss jordan method:")
print(solution_of_the_system_of_equations)
```

OUTPUT

```
IDLE Shell 3.13.0
File  Edit  Shell  Debug  Options  Window  Help
Python 3.13.0 (tags/v3.13.0:60403a5, Oct  7 2024, 09:38:07) [MSC v.1941 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:/Users/PaySprint/AppData/Local/Programs/Python/Python313/pr-04.py =
Enter the dimension of coefficients matrix (A)
Enter the number of rows: 3
Enter the number of columns: 3
Enter the elements of coefficients matrix (A) as a single line (separated by space):
3 6 8 2 0 1 9 4 7
Coefficient Matrix (A) is as follows:
 [[3. 6. 8.]
 [2. 0. 1.]
 [9. 4. 7.]]

Enter the elements of column matrix (B) as a single line (separated by space):
3 8 6
Column Matrix (B) is as follows:
 [[3.]
 [8.]
 [6.]]

Solution of the system of equations using Gauss jordan method:
[[105.]
 [ 12.]
 [101.]]
>>>
Ln: 8  Col: 84
```

PRACTICAL -05

#Verify the linear dependence of vectors generate a linear combination of given vectors of Rn/matrices of the same size.

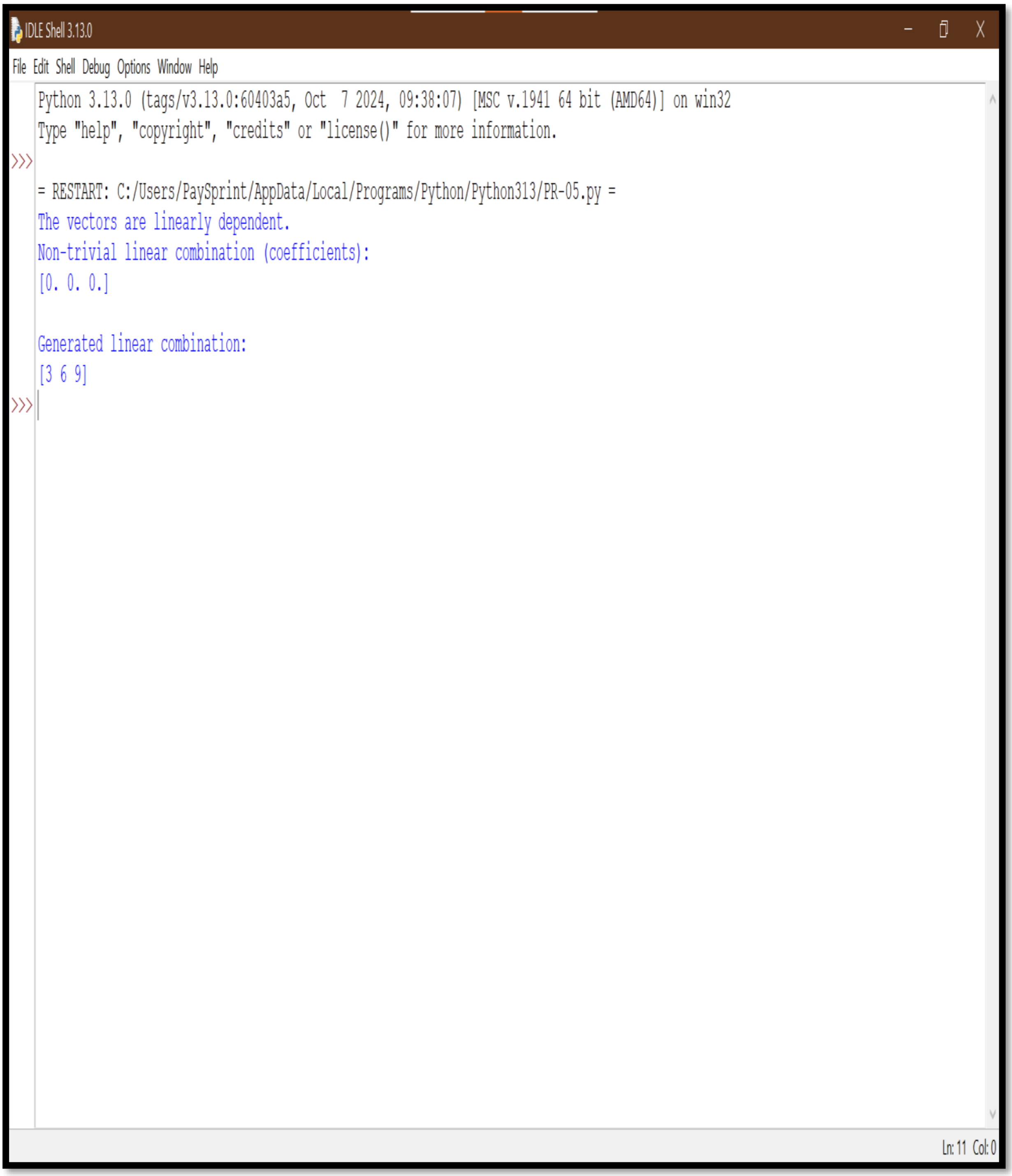
PR-05.py - C:/Users/PaySprint/AppData/Local/Programs/Python/Python313/PR-05.py (3.13.0)

File Edit Format Run Options Window Help

```python
#PRACTICAL-05
import numpy as np

def is_linearly_dependent(vectors):
    # Convert the list of vectors to a numpy matrix (each vector is a column)
    A = np.column_stack(vectors)

    # Perform row reduction (Gaussian elimination)
    rank = np.linalg.matrix_rank(A)

    # If the rank of the matrix is less than the number of vectors, they are linearly dependent
    if rank < A.shape[1]:
        print("The vectors are linearly dependent.")
        # Find a non-trivial solution to the equation A * c = 0
        # where c is the vector of coefficients
        # Solve A * c = 0 (using least squares)
        c = np.linalg.lstsq(A, np.zeros(A.shape[0]), rcond=None)[0]
        print("Non-trivial linear combination (coefficients):")
        print(c)
    else:
        print("The vectors are linearly independent.")

def generate_linear_combination(vectors, coefficients):
    # Linear combination of vectors based on given coefficients
    result = np.zeros_like(vectors[0])
    for i, vec in enumerate(vectors):
        result += coefficients[i] * vec
    return result

# Example: 3 vectors in R^3 (3D space)
v1 = np.array([1, 2, 3])
v2 = np.array([2, 4, 6])
v3 = np.array([3, 6, 9])
```

Ln: 11 Col: 0

OUTPUT


IDLE Shell 3.13.0
File Edit Shell Debug Options Window Help
Python 3.13.0 (tags/v3.13.0:60403a5, Oct 7 2024, 09:38:07) [MSC v.1941 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:/Users/PaySprint/AppData/Local/Programs/Python/Python313/PR-05.py =
The vectors are linearly dependent.
Non-trivial linear combination (coefficients):
[0. 0. 0.]
Generated linear combination:
[3 6 9]
>>>
Ln: 11 Col: 0

PRACTICAL -06

#Check the diagonalizable property of matrices and find the corresponding eigenvalue and verify the Cayley Hamilton theorem.

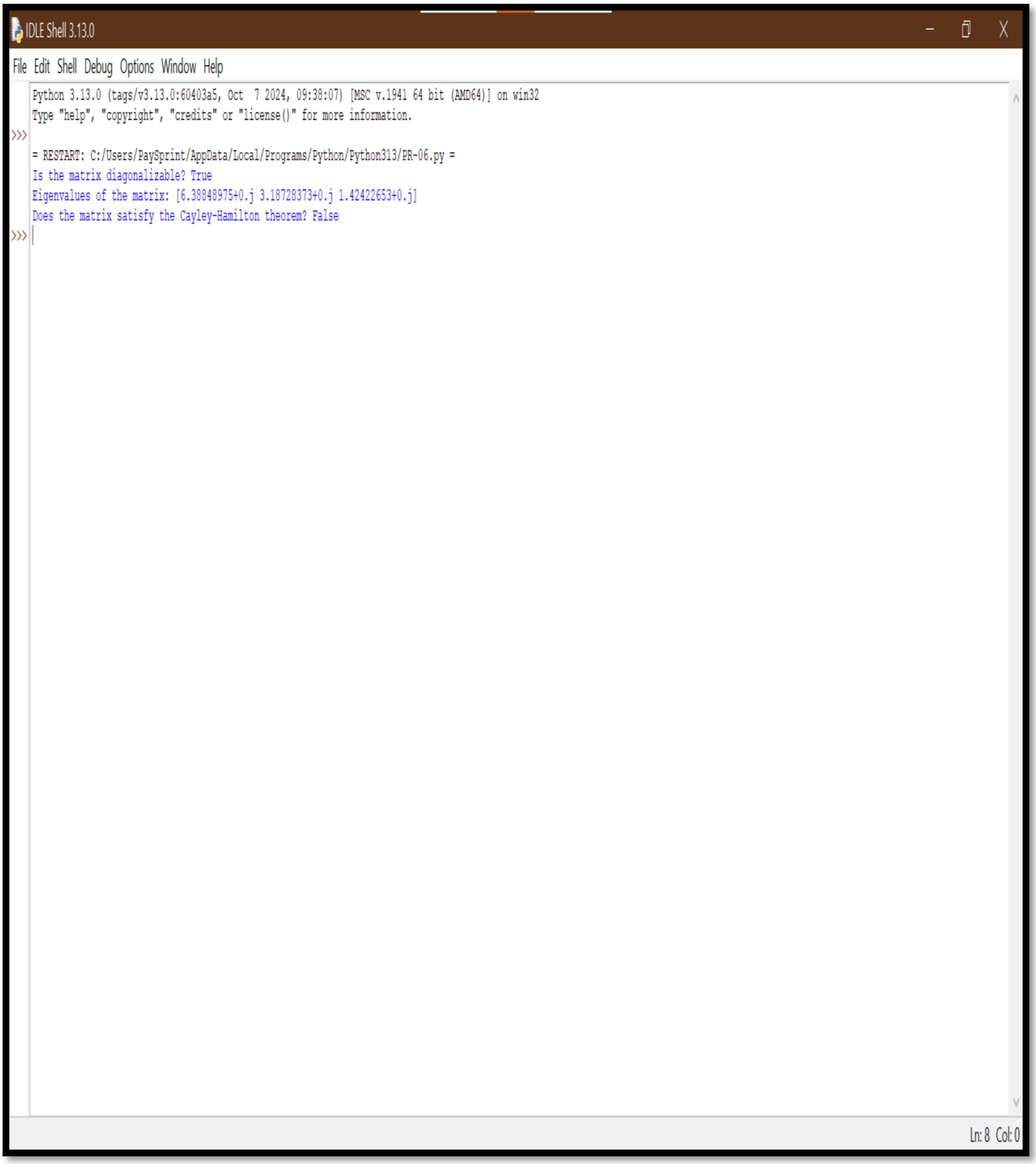
PR-06.py - C:/Users/PaySprint/AppData/Local/Programs/Python/Python313/PR-06.py (3.13.0)

File Edit Format Run Options Window Help

```python
#PRACTICAL-06
import numpy as np
from scipy.linalg import eig
from sympy import Matrix, symbols, det

# Function to check diagonalizability
def is_diagonalizable(A):
    # Compute eigenvalues and eigenvectors
    eigenvalues, eigenvectors = eig(A)

    # Check the geometric multiplicity (number of independent eigenvectors)
    # If the number of independent eigenvectors matches the size of the matrix, it's diagonalizable
    rank = np.linalg.matrix_rank(eigenvectors)
    if rank == A.shape[0]:
        return True, eigenvalues
    else:
        return False, eigenvalues

# Function to verify the Cayley-Hamilton theorem
def verify_cayley_hamilton(A):
    # Convert matrix to sympy Matrix
    A_sympy = Matrix(A)

    # Compute the characteristic polynomial
    lambda_symbol = symbols('lambda')
    char_poly = A_sympy.charpoly(lambda_symbol)

    # The characteristic polynomial as a sympy expression
    characteristic_polynomial = char_poly.as_expr()

    # Replace lambda with the matrix A in the characteristic polynomial
    A_substitution = characteristic_polynomial.subs(lambda_symbol, A_sympy)

    # Check if the result is the zero matrix (Cayley-Hamilton should hold)
    return A_substitution.is_zero

# Example matrix
A = np.array([[4, -1, 1],
              [-1, 4, -2],
              [1, -2, 3]])

# Step 1: Check if the matrix is diagonalizable
diagonalizable, eigenvalues = is_diagonalizable(A)
print("Is the matrix diagonalizable?", diagonalizable)
print("Eigenvalues of the matrix:", eigenvalues)

# Step 2: Verify Cayley-Hamilton theorem
is_cayley_hamilton_true = verify_cayley_hamilton(A)
print("Does the matrix satisfy the Cayley-Hamilton theorem?", is_cayley_hamilton_true)
```

Ln: 6 Col: 0

OUTPUT


IDLE Shell 3.13.0
File Edit Shell Debug Options Window Help
Python 3.13.0 (tags/v3.13.0:60403a5, Oct 7 2024, 09:38:07) [MSC v.1941 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:/Users/PaySprint/AppData/Local/Programs/Python/Python313/PR-06.py =
Is the matrix diagonalizable? True
Eigenvalues of the matrix: [6.38848975+0.j 3.18728373+0.j 1.42422653+0.j]
Does the matrix satisfy the Cayley-Hamilton theorem? False
>>>
Ln: 8 Col: 0

PRACTICAL -07

Compute Gradient of a scalar field, Divergence and Curl of a vector filed.

```python
#PRACTICAL -07
import sympy as sp

# Define symbols (coordinates)
x, y, z = sp.symbols('x y z')

# Example Scalar Field f(x, y, z)
f = x**2 + y**2 + z**2

# Example Vector Field A(x, y, z)
A_x = x * y
A_y = y * z
A_z = z * x
A = sp.Matrix([A_x, A_y, A_z])

# 1. Compute the Gradient of the scalar field f
gradient_f = sp.Matrix([sp.diff(f, var) for var in (x, y, z)])
print("Gradient of f(x, y, z):")
sp.pprint(gradient_f)

# 2. Compute the Divergence of the vector field A
divergence_A = sp.diff(A_x, x) + sp.diff(A_y, y) + sp.diff(A_z, z)
print("\nDivergence of A(x, y, z):")
sp.pprint(divergence_A)

# 3. Compute the Curl of the vector field A
curl_A = sp.Matrix([
    sp.diff(A_z, y) - sp.diff(A_y, z),  # i-component
    sp.diff(A_x, z) - sp.diff(A_z, x),  # j-component
    sp.diff(A_y, x) - sp.diff(A_x, y)   # k-component
])
print("\nCurl of A(x, y, z):")
sp.pprint(curl_A)
```

OUTPUT

```
Python 3.13.0 (tags/v3.13.0:60403a5, Oct  7 2024, 09:38:07) [MSC v.1941 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>> 
= RESTART: C:/Users/PaySprint/AppData/Local/Programs/Python/Python313/PR-07.py =
Gradient of f(x, y, z):
⎡2⋅x⎤
⎢   ⎥
⎢2⋅y⎥
⎢   ⎥
⎣2⋅z⎦

Divergence of A(x, y, z):
x + y + z

Curl of A(x, y, z):
⎡-y⎤
⎢  ⎥
⎢-z⎥
⎢  ⎥
⎣-x⎦
>>> 
```