

- (c) Write a Python code using pandas to create a data frame with the following data by reading as python dictionary with the following columns: Name, Age, and City.

Name	Age	City
Alice	23	New York
Bob	35	Los Angeles
Charlie	45	Chicago
David	29	New York
Eve	22	Los Angeles

- (i) Change name of the column City to Town.  
(ii) Drop the second column Age,  
(iii) Add a new column called Income to the data frame with the following values:  
Alice: 70000, Bob: 85000, Charlie: 95000,  
David: 72000 and Eve: 93000.
- (d) Write a python code using PyLaTeX to create a table with 5 columns and 4 rows as a LaTeX Document.

(4000)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7080

K

Unique Paper Code : 2353012002

Name of the Paper : Mathematical Python

Name of the Course : **B.Sc. (Hons.) Mathematics-DSE**

Semester : III

Duration : 3 Hours

Maximum Marks : 90

**Instructions for Candidates**

- Write your Roll No. on the top immediately on receipt of this question paper.
  - Attempt **all** questions by selecting any **six** parts from question number **1**, and any **three** parts from question numbers **2** to **6** respectively.
  - All commands to be written in Python code.
1. Attempt any **6** parts. (2.5×6=15)
- (a) Write code to print first ten non negative even numbers using for-loop.

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(b) Consider the following code:

```
import random
sum1 = 0
trails = 1000000
for i in range(trails):
    num = random.random()
    sum1 = sum1 + num
print("Output = ", sum1/trails)
```

write the approximate output of the above code.

(c) What is the output of the following code:

```
x = np.linspace(-3,3,7)
y = x**2
print(y)
```

(d) Write the usage of the following properties in the plot function of matplotlib:

- (i) linestyle
- (ii) alpha

(e) Draw the output of the following code:

```
import numpy as np
import matplotlib.pyplot as plt
t = np.linspace(0, 2*np.pi, 100)
plt.plot(np.sin(t), np.cos(t))
plt.show()
```

(ii) Define a recursive function to generate the  $n^{\text{th}}$  term in the Fibonacci sequence, where:

$$F(n) = F(n - 1) + F(n - 2)$$

with initial terms  $F(0) = 0, F(1) = 1$ .

6. Attempt any 3 parts.

(5×3=15)

(a) Write a SymPy code to obtain and verify the solution of the following system of linear equations:

$$3x + 4y = 10$$

$$2x - y = 1$$

(b) For the given matrix:

$$A = \begin{pmatrix} 1 & 2 & 3 \\ -2 & 0 & 4 \end{pmatrix}$$

Write a python code using SymPy to perform the following operations;

- (i) Create the matrix A and evaluate  $A^2$
- (ii) Display the first row and last column of the matrix A.
- (iii) Find the determinant and transpose of the matrix A.

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- (d) Find the general solution of the following second order differential equation using SymPy. Further verify the solution.

$$\frac{d^2y}{dx^2} - 25y = 0$$

5. Attempt any 3 parts.

(5×3=15)

- (a) Write a SymPy code to factorize the expression  $x^2 - x - 6$  and to expand  $(x + y)^2$ .

- (b) Write a SymPy code to find the critical points of the following function and print the points of local maxima and minima.

$$f(x) = -x^2 + 3x - 2$$

- (c) Write a NumPy code to solve the following system of linear equations using the inverse of coefficient matrix :

$$6x - 5y + 2z = 3$$

$$2x + y - 4z = 5$$

$$3x - 3y + z = -1$$

- (d) Write a python code for the following :

- (i) Using SymPy, find the series expansion of  $e^x$  around  $x = 0$  up to the order  $x^4$ .

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- (f) Suppose myTurtle is a turtle object. Write commands to move it forward 100 units, turn right and then move again forward 200 units.

- (g) Write SymPy code to evaluate  $\lim_{x \rightarrow \infty} \frac{1}{x}$ .

- (h) Use SymPy code to evaluate the second derivative of

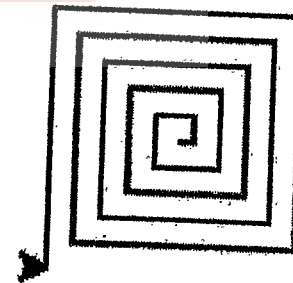
$$x^3 + x + 1 \text{ at } x = 2.$$

2. Attempt any 3 parts.

(2.5×6=15)

- (a) Define a function that takes a list of numbers as input and returns maximum of all list elements as output (you are not suppose use inbuilt function for the same).

- (b) Use turtle to draw the following pattern:



P.T.O.

(c) Consider the following rainfall data :

56, 65, 76, 87, 67, 58, 65, 76, 87, 67, 57, 66

over 12 months in a city. Make a Line plot of the above: data, also add a square marker for each data point. Also display the months on x-axis by numbers 1, 2, 3 ..., 12.

(d) Define a function that simulates a biased coin that returns 'head' with probability 2/3 and returns tail with probability 1/3.

5. Attempt any 3 parts.

(5×3=15)

(a) Write a python code using NumPy to compute the inverse of the given matrix

$$A = \begin{pmatrix} 1 & 3 & -2 \\ 3 & 5 & 6 \\ 2 & 4 & 3 \end{pmatrix}$$

(b) Use lambda function to evaluate the following function at  $x = 0$

$$f(x) = \sqrt{(x + x^2 + x^3)}$$

(c) Write a SymPy code to print and evaluate the area enclosed between the two curves  $f(x) = x$  and  $g(x) = x^2$  with the x-axis between  $x = 0$  and  $x = 2$ .

(d) Write a SymPy code to calculate the first order derivative of the following function and solve  $f(x) = 0$  to find the critical points

$$f(x) = x^5 + 30x^3 + 50x$$

4. Attempt any 3 parts.

(5×3=15)

(a) Plot a bar chart representing the total precipitation in Delhi for each month in 2023. According to Indian Agricultural Research Institute (IARI), New Delhi we have the following rainfall data (in millimeters) month-wise in 2023 :

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
41	00	105	109	118	234.8	366.0	431.2	85	40	12.4	0.0

(b) Write a python code using NumPy and matplotlib to plot the all the five solutions  $y(t)$  over the interval  $0 \leq x \leq 5$  for each initial value  $y(0) = 1, 2, 3, 4, 5$  of following function :

$$\frac{dy}{dt} = -2t$$

(c) Using lambdify, write python code to evaluate the following function at  $x=1$

$$\sin x + \cos x$$