

This question paper contains 6 printed pages]

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S. No. of Question Paper : 3377

Unique Paper Code : 2354000007

Name of the Paper : Mathematical Python (General Elective)

Name of the Course : Common Programme Group

Semester : V

Duration : 3 Hours

Maximum Marks : 90

(Write your Roll No. on the top immediately on receipt of this question paper.)

There are six questions in the question paper and *all* are compulsory, there are internal choices in each question.

All questions carry equal marks and there is an *equal* distribution of marks for all parts within each question.

All commands and codes are to be written in Python Programming only.

Calculators are not allowed.

1. Attempt any six parts :

2.5×6=15

- (a) Write the python code using Turtle to plot a regular pentagon with 70 cm of edge length.
- (b) How do you distinguish methods and functions with each other in Python ? Write the syntax for any two for each.
- (c) Write the data type of the following :
 - (i) [41 27 89 -7]
 - (ii) (5.0, 21.5, 74.1, 28.2)
 - (iii) 12/13
 - (iv) ['a', 'b', 'c', 'd']
 - (v) [[-12, 21 -31, 17]].

P.T.O.

- (d) Describe any *two* widely used modules in Python and explain why they are important.
- (e) Using slicing in Python programming, split the list $L1 = [12, 13, 15, 17, 18, 20, 22, 23, 25, 27, 28, 30]$ into the two sublists $L2$ and $L3$, where $L2 = [12, 15, 18, 22, 25, 28]$ and $L3 = [13, 17, 20, 23, 27, 30]$.
- (f) Explain mutability in Python data structures. Which of the following are mutable data type :
- (i) List
 - (ii) Array
 - (iii) Set
 - (iv) Tuple
 - (v) Dictionary.
- (g) Write SymPy code to compute $\int_{-\infty}^{+\infty} \cos(x^2) dx$.
- (h) Use SymPy for pretty printing of $x^5 + 3x^4 - 2x^2 + 5x + 1$ in reverse lexicographical order.
2. Attempt any *three* parts : 5×3=15
- (a) Write a code that plots 45 squares, turning left 8 degrees after each square that makes the turtle move with the fastest pace.
 - (b) Write a program that asks the user to input a natural number and determines the factorial of that input number. What is the program output if the input number is 6 ?
 - (c) Define NumPy 1-D, 2-D and 3-D arrays. Give commands to construct appropriate examples for each.

- (d) Compose a Python code to show a vertical bar plot for the following enrollment data of the students in a skill training workshop. Use appropriate legends and a suitable title for the plot :

Prog. Language	C++	Fortran	Java	R	Python
Enrollments	20	15	30	9	35

3. Attempt any *three* parts :

5×3=15

- (a) Write a Python program that solves the following system of linear equations using the inverse of the coefficient matrix :

$$x + 3y - 2z = 1$$

$$3x + 5y + 6z = 31$$

$$2x + 4y + 3z = 19$$

- (b) Write a program in Python that prompts user a positive integer input value m and prints the series $1 + y^2 + y^4 + y^6 + \dots + y^{2m}$ as output.
- (c) Write a program to solve the system of equations :

$$x^2 - 2x - y^2 = -1$$

$$x^2 - 2y = 1.$$

- (d) Write the Python commands to perform the following operations on the matrix :

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

- (i) Create the matrix A
- (ii) Find eigenvalues and eigenvectors of A.

4. Attempt any *three* parts :

5×3=15

- (a) Write a program to find the first and second order derivatives of the function $f(x) = x^4 + 7x^2 - 3x \sin(x)$. Further give command to evaluate $f''(0)$.
- (b) Write a Python code to solve the following differential equation and check that the solution is correct :

$$x \frac{d^2y}{dx^2} + 3 \frac{dy}{dx} - y = 0.$$

- (c) Write a program that calculates left-hand limit $\lim_{x \rightarrow 0^-} \frac{|x|}{x}$ and right-hand limit $\lim_{x \rightarrow 0^+} \frac{|x|}{x}$.
- (d) Write Python commands to solve the initial value problem :

$$6y''(t) - 5y'(t) + y(t) = 0, y(0) = 4, y'(0) = 0,$$

where $y'(t)$ and $y''(t)$ denote the first and second order derivative of y with respect to t .

5. Attempt any *three* parts :

5×3=15

- (a) Given the first three elements of the sequence $\{Q_n\}$, $Q_1 = 2$, $Q_2 = 5$ and $Q_3 = 8$, write a Python program to find the next five terms of the sequence that is recursively defined by the relation :

$$Q_{n+3} = \frac{2Q_{n+1} + Q_{n+2}}{Q_n + 1}, n \geq 1$$

- (b) What would be the output of the following SymPy commands :

```
from sympy import *
```

```
x, y = symbols('x y')
```

```
expr = x*x - x*y + 2*x*y + y*y+1
```

```
pprint(expr)
```

```
res1 = expr.subs((x: -2, y: -3))
```

```
res2 = expr.subs((x: y-1))
```

```
print(res1, res2).
```

- (c) Write Python code using SymPy to find all real solutions to this inequality :

$$\frac{2x - 3}{x - 4} > 0.$$

- (d) Use the finite difference method to approximate the second derivative of $f(x) = \sin(x)$ at $x = 0.5$ using the central difference formula with step size $h = 0.1$. The central difference approximation of the second derivative is given by :

$$f''(x) \approx \frac{f(x+h) - 2f(x) + f(x-h)}{h^2}.$$

Calculate the exact value of $f''(0.5)$ analytically. Compare the numerical approximation with the exact value by computing the absolute error.

6. Attempt any *three* parts :

5×3=15

- (a) Read the following scores.csv file and create a dataframe using pandas, saving it as df.

Student, Math, English, Biology, Chemistry

Alice,85,92,,

Bob,78,86,91,

Charlie,93,88,85,95

Diana,88,94,90,92

Given Python code for the following :

- (i) Change the name of the column Math to Mathematics
- (ii) Drop the first row of Alice
- (iii) Fill the NaN values with the mean of their respective columns.

- (b) Use matplotlib to write code to draw a pie chart for the following data :

<i>Categories</i>	<i>H</i>	<i>I</i>	<i>J</i>	<i>K</i>	<i>L</i>	<i>M</i>	<i>N</i>
<i>Values</i>	35.2	24.5	50.8	15.9	65.3	28.7	42.1

- (c) Write a SymPy code to print and evaluate the integral :

$$\int_5^{10} \frac{1}{\sqrt{2\pi}} e^{-\frac{(x-7)^2}{2}} dx$$

- (d) Use PyLaTeX to create a document with a section named "Differential Equations" and include the following mathematical expression in the section content :

$$\frac{d^2y}{dx^2} + 5 \frac{dy}{dx} + 6y = 0$$

Write Python code using PyLaTeX to generate this document.