STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 86
(For candidates admitted from the academic year 2023 – 2024 and thereafter)

M.Sc. DEGREE EXAMINATION, APRIL 2024
BRANCH I - MATHEMATICS
SECOND SEMESTER

COURSE : ELECTIVE
PAPER : MATHEMATICAL PYTHON
SUBJECT CODE : 23MT/PE/MP15
TIME : 3 HOURS **MAX. MARKS: 100**

THEORY:

Q. No.	SECTION A ($10 \times 1 = 10$) **Answer ALL questions**	CO	KL
1.	Which of the following can be used as valid variable identifier in Python? (a) 4thSum (b) nthSum (c) Sum# (d) Sum n	1	1
2.	What is the syntax for a basic if statement in Python? (a) if-then (b) if-then-else (c) if-elif-else (d) if-elseif	1	1
3.	Which data structure in Python is ordered and mutable? (a) list (b) tuple (c) dictionary (d) set	1	1
4.	Which function is used to add a node to a graph in NetworkX? (a) add_node() (b) insert_node() (c) create_node() (d) node()	1	1
5.	Which loop is used when the number of iterations is known? (a) for loop (b) while loop (c) do-while loop (d) None of these	1	1
6.	What is the purpose of the try-except block in Python? (a) To define a custom function (b) To handle exceptions and errors (c) To open a file for writing (d) To loop over a sequence of items	1	1
7.	Which file format is commonly used for storing tabular data? (a) HTML (b) JSON (c) CSV (d) XML	1	1
8.	Which Python keyword is used to define a custom module? (a) module (b) define (c) import (d) moduledef	1	1
9.	What is the purpose of the “solve” function in SymPy? (a) To perform symbolic mathematics (b) To solve algebraic equations (c) To plot mathematical functions (d) To generate random numbers	1	1
10.	Which optimization technique involves iteratively updating parameters to minimize a cost function? (a) Gradient descent (b) Genetic algorithms (c) Simulated annealing (d) Newton's method	1	1

Q. No.	SECTION B ($10 \times 1 = 10$) **Answer ALL questions**	CO	KL
11.	Which data structure in Python is best suited for storing key-value pairs? (a) list (b) tuple (c) dictionary (d) set	2	2
12.	What is the purpose of list comprehension in Python? (a) To create a list by applying an operation to each element of another list (b) To create a list by merging multiple lists together (c) To sort a list in ascending order (d) To remove elements from a list	2	2
13.	What is the purpose of a Python module? (a) To store data in a structured format (b) To create graphical user interfaces (c) To organize code into reusable components (d) To perform numerical computations	2	2
14.	What is the purpose of the np.arange() function in NumPy? (a) To create an array with equally spaced values within a specified range (b) To generate a sequence of random numbers (c) To calculate the dot product of two arrays (d) To reshape an array into a specified shape	2	2
15.	What is the purpose of SymPy in Python? (a) To perform numerical computations (b) To solve mathematical equations symbolically (c) To create graphical visualizations (d) To handle exceptions and errors	2	2
16.	What is a graph in the context of graph theory? (a) A mathematical representation of data using nodes and edges (b) A visual representation of data using bars of different heights (c) A method for organizing data into rows and columns (d) A technique for predicting future trends based on past data	2	2
17.	What is the primary purpose of the NetworkX package in Python? (a) Text processing (b) Web development (c) Graph theory and analysis (d) Machine learning	2	2
18.	Which type of regression analysis is suitable for predicting a continuous outcome variable based on one or more predictor variables? (a) Linear regression (b) Logistic regression (c) Polynomial regression (d) Ridge regression	2	2
19.	Which Python library is commonly used for simulation of mathematical models and physical systems? (a) NumPy (b) SymPy (c) SciPy (d) SimPy	2	2
20.	How do you represent a differential equation in Python for numerical solution? (a) As a string (b) As a list of coefficients (c) As a function (d) As a symbolic expression	2	2

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PRACTICAL:

Q. No.	**SECTION C ($2 \times 20 = 40$)** **Answer ANY TWO questions**	CO	KL
16.	(a) Create a Python script that demonstrates the use of list comprehensions to generate a list of squares of numbers from 1 to 10. (b) Write a Python program to calculate the prime numbers up to a given number.	3	3
17.	Demonstrate the use of NumPy to perform curve fitting on a set of experimental data points, predict the unknown value and visualize the results using Matplotlib.	3	3
18.	Implement the gradient descent algorithm to find the minimum of the function $f(x) = x^2 + 5x + 6$. Start with an initial guess of $x_0 = 0$ and use a learning rate of $\alpha = 0.1$.	3	3

Q. No.	**SECTION D ($2 \times 10 = 20$)** **Answer ANY TWO questions**	CO	KL
19.	Develop a Python program that reads data from a CSV file, performs some calculations on the data, and then writes the results to a new CSV file.	4	4
20.	Write a Python script to construct a simple undirected graph using NetworkX, with nodes representing cities and edges representing roads between them. Add nodes and edges to the graph, and visualize the resulting graph using Matplotlib. Also determine the shortest route between the cities.	4	4
21.	Create a module that includes functions for basic mathematical operations (addition, subtraction, multiplication, division and some more). Test the module by importing it into a script and using these functions to perform calculations.	4	4
22.	Generate plots of 4 mathematical functions and present it as a 2×2 grid and save the overall plot as a PNG file.	4	4

Q. No.	**SECTION E ($2 \times 10 = 20$)** **Answer ANY TWO questions**	CO	KL
23.	Using appropriate Python Module: (a) Find the real solutions of the equation $2x^6 - 5x^4 + 3x^3 - x^2 + 4x - 7 = 0$. (b) Solve the following system of equations: $2x_1 - 3x_2 + x_3 + 4x_4 - 5x_5 = 10$ $3x_1 + 4x_2 - 2x_3 - x_4 + 2x_5 = -5$ $x_1 - 2x_2 + 3x_3 + x_4 - 2x_5 = -3$ $-x_1 + 3x_2 - x_3 + 2x_4 + x_5 = 1$ $2x_1 + x_2 - 4x_3 + x_4 + 3x_5 = 8$	5	5

..2

24.	Demonstrate the various matrix operations to be performed in SymPy.	5	5
25.	Using appropriate Python Module: (a) Solve the first-order ordinary differential equation $\frac{dy}{dx} = x^2 - 2x.$ (b) Find the general solution of the second order homogeneous differential equation $y'' + 4y = 0$.	5	5
26.	Evaluate using appropriate Python module: (a) Expand in a series of powers of x: $\frac{3 - 7x^2}{(1 - 3x)(2x + 3)(x + 2)}$ (b) $\lim_{x \to 0} \frac{3^x + 1 - \cos x - e^x}{x}$ (c) $\int_0^{\pi} \frac{\pi \tan x}{\sec x + \tan x}$	5	5