STELLA MARIS COLLEGE (AUTONOMOUS), CHENNAI – 600 086
(For candidates admitted during the academic year 2023 -2024 & thereafter)

M.Sc. DEGREE EXAMINATION – APRIL 2026
BRANCH III - PHYSICS
FOURTH SEMESTER

CODE : ELECTIVE
PAPER : INTRODUCTION TO R PROGRAMMING - THEORY
SUBJECT CODE : 23PH/PE/IR15
TIME : 2 HOURS **MAX. MARKS : 60**

Q. No.	SECTION A ANSWER ALL QUESTIONS (10 x 3 = 30)	CO	KL
1	Define the R workspace and explain how to save and load your current session.	1	1
2	List four major features of R that make it a preferred language for data analysis.	1	1
3	Differentiate between a Vector and a List in R with a simple example.	1	1
4	What is a recursive function? How is a recursive call structured in R.	2	2
5	Explain the switch statement in R and how it differs from a standard if-else block.	2	2
6	Briefly describe the repeat loop and the keyword used to exit it.	2	2
7	When would you use a Box plot over a Histogram for data visualization?	2	2
8	Explain the parameters required to create a basic Bar chart for categorical data.	3	3
9	State the mathematical formula for the Trapezoidal rule used in numerical integration.	3	3
10	Briefly explain the core principle behind Newton-Rapson method for finding roots.	3	3
Q. No.	**SECTION B**		
	Part A **ANSWER ANY TWO QUESTIONS (2 x 5 = 10)**		
11	Explain the various types of operators available in R (Arithmetic, Relational, and Logical) with illustrative examples for each.	3	3
12	What are Data Frames? Explain how they differ from Matrices and demonstrate how to perform data type conversion between them.	3	3
13	Discuss the different types of input/output operations in R, specifically focusing on reading from and writing to external files.	3	3
	Part B **ANSWER ANY TWO QUESTIONS (2 x 10 = 20)**		
14	Compare and contrast for, while, and vector-based programming in R. Provide code examples for each to calculate the sum of the first 100 integers and discuss which method is most efficient in the R environment.	4	4
15	You are given a dataset containing the sales figures of five different products over four quarters. Describe the step-by-step process to visualize this data using: o Grouped Bar Chart. o Line Graph with multiple lines. o 3D Pie Chart. *(Include the specific functions and key arguments used for each).*	4	4
16	Explain the Runge-Kutta method for solving ordinary differential equations. Provide a conceptual algorithm or flowchart for implementing this in R.	4	4

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SCHEME

INTRODUCTION TO R – PROGRAMMING (THEORY) **CODE: 23PH/PE/IR15**

Time: 2 Hr. **Max. Mark: 60**

Section-A, Answer ALL questions **(10 x 3 = 30)**

1. Define the R workspace and explain how to save and load your current session.
   The workspace is your current active environment containing all defined objects and functions; you can save it using save.image("filename.RData") and restore it later with load("filename.RData")
2. List four major features of R that make it a preferred language for data analysis.
   R provides a massive ecosystem of specialized packages for statistical analysis, powerful built-in data visualization capabilities, efficient matrix and vector operations, and is free, open-source software.
3. Differentiate between a Vector and a List in R with a simple example.
   Vectors are homogeneous data structures containing elements of the same type (e.g., v <- c(1, 2, 3)), whereas lists are heterogeneous structures that can hold elements of different types (e.g., l <- list(1, "A", TRUE)).

4. What is a recursive function? How is a recursive call structured in R.
   A recursive function solves a problem by calling itself with smaller inputs, necessitating a base case to terminate execution and avoid an infinite loop.
5. Explain the switch statement in R and how it differs from a standard if-else block.
   The switch statement selects and executes a specific expression from a list based on an index or string match, while if-else blocks handle branching logic based on general conditional evaluations.
6. Briefly describe the repeat loop and the keyword used to exit it.
   loop executes code indefinitely until an explicit break statement is reached; it is used when the termination condition is checked mid-execution rather than at the start.
7. When would you use a Box plot over a Histogram for data visualization?
   Use a Box plot when comparing the distribution, spread, and outliers of a numerical variable across different categories, and a Histogram when visualizing the overall frequency distribution of a single continuous variable.
8. Explain the parameters required to create a basic Bar chart for categorical data.
   A basic bar chart requires a vector of numerical values (heights of the bars) and a vector of labels (names of the categories) passed as arguments to the barplot() function.
9. State the mathematical formula for the Trapezoidal rule used in numerical integration.
   Trapezoidal Rule: The rule approximates the definite integral as,
   $\int_a^b f(x)dx \approx \frac{1}{2}h(y_0 + 2y_1 + 2y_2 + \ldots + 2y_{n-1} + y_n)$
   Where, h = (b – a)/n
10. Briefly explain the core principle behind Newton-Rapson method for finding roots.
    This iterative root-finding algorithm approximates the root of f(x)=0 by repeatedly drawing tangent lines to the curve, using the formula,
    $$x_{r+1} = x_r - \frac{f(x_r)}{f'(x_r)}$$

Section-B, Answer TWO questions (2 x 5 = 10)

11. Explain the various types of operators available in R (Arithmetic, Relational, and Logical) with illustrative examples for each.
    Focus on defining Arithmetic for calculations (e.g., +, %% for modulus), Relational for comparisons (e.g., ==, != returning Booleans), and Logical for combining conditions (e.g., &, |, !). Provide a one-line code snippet like (x + 5 > 10) & (y == 2) to show how they interact in a single expression. Briefly mention that these operators are "vectorized," meaning they apply to every element in a vector simultaneously.
12. What are Data Frames? Explain how they differ from Matrices and demonstrate how to perform data type conversion between them.
    Define a Data Frame as a 2D table that allows heterogeneous data (different types per column), while a Matrix is a 2D array that must be homogeneous (one type only). Explain that matrices are faster for mathematical operations, whereas data frames are better for datasets containing names and numbers. Demonstrate the conversion using the functions as.matrix() to flatten data into one type and as.data.frame() to allow flexible column types.
13. Discuss the different types of input/output operations in R, specifically focusing on reading from and writing to external files.
    Describe Input methods like read.csv() or read.table() for importing external datasets and scan() for flexible, manual data entry. Explain Output operations using write.csv() or write.table() to save results to your hard drive, emphasizing the importance of the row.names=FALSE argument to keep files clean. Mention that sink() can be used to redirect all console output directly into a text file for logging purposes.

Section-C, Answer TWO questions **(2 x 10 = 20)**

14. Compare and contrast for, while, and vector-based programming in R. Provide code examples for each to calculate the sum of the first 100 integers and discuss which method is most efficient in the R environment.
15. You are given a dataset containing the sales figures of five different products over four quarters. Describe the step-by-step process to visualize this data using:
    - Grouped Bar Chart.
    - Line Graph with multiple lines.
    - 3D Pie Chart. *(Include the specific functions and key arguments used for each).*
16. Explain the Runge-Kutta method for solving ordinary differential equations. Provide a conceptual algorithm or flowchart for implementing this in R.