

**MASTER OF SCIENCE (DATA
SCIENCE AND ANALYTICS)
(MSCDSA)**

Term-End Examination

June, 2026

MCS-061 : MATHEMATICAL FOUNDATIONS-I

Time : 3 Hours

Maximum Marks : 100

Note : *Question No. 1 is compulsory. Attempt any **three** questions from the rest.*

1. (a) If a set A is defined as $A = \{x : x \text{ is a prime number and } 1 < x < 10\}$, calculate the total number of elements in its power set $P(A)$. From this total, how many are considered as proper subset ? 5

- (b) Given a finite set A with 3 elements and a finite set B with 2 elements, calculate the total number of distinct relations that can be formed from A to B . Based on the mathematical definition of a relation, why is the ‘empty set’ ($\emptyset$) included in this total ? 5
- (c) Given the functions $f(x) = x^2$ and $g(x) = x + 2$, calculate the value of composite function $(g \circ f)(5)$ and $(f \circ g)(5)$. 5
- (d) Algebraically demonstrate why the equation of a circle $x^2 + y^2 = 4$ does not correspond to a mathematical function. If you were to apply a “Vertical Line Test” to its graph, what would you observe ? 5

- (e) If the expressions $(5k + 1)$, $(6k + 5)$ and $(10k + 3)$ are three consecutive terms of an Arithmetic Progression (A.P.), determine the value of ' k '. Why is the relationship between these three terms sufficient to solve for the variable ' k ' ? 5

- (f) Given the matrices $A = \begin{bmatrix} 3 & x + y \\ xy & 7 + z \end{bmatrix}$ and

$$B = \begin{bmatrix} 3 & 6 \\ 8 & 4 \end{bmatrix}, \text{ determine the values of } x, y$$

and z , if $A = B$. State the conditions when two matrices can be said equal. 5

- (g) Without performing full expansion,

$$\text{determine the value of } |A| = \begin{vmatrix} 1 & 2 & 3 \\ 2 & 4 & 1 \\ 1 & 2 & 4 \end{vmatrix}.$$

Which specific property of determinants justifies your result ? 5

- (h) Find the eigen values (λ_1, λ_2) of the

square matrix $A = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$. 5

2. (a) Verify that the limit $\lim_{x \rightarrow 4} \frac{|x - 4|}{x - 4}$ exists

or not. Support your verification statement with suitable arguments. 5

- (b) Using the First Principle (Delta Method), find the derivative of the function $f(x) = x^2$. 5

- (c) Evaluate the intergral $\int x^3 dx$. Explain why the answer to the integral will be incomplete if the constant (C) is not included in the result. 5

- (d) Numerically evaluate $\int_2^6 8dx$. Explain why it is a standard practice to omit the arbitrary constant (C) when solving the definite integral, even though it is required for indefinite integral. 5
3. (a) State Binomial theorem and use it to derive formula for identities $(a + b)^2$, and $(a + b)^3$. 6
- (b) Draw Venn diagrams for the following operations between set A and set B : 6
- (i) $A - B$
 - (ii) $A \Delta B$
 - (iii) $A \cap B$
- (c) Describe the meaning of non-reflexive and anti-reflexive property of any relation, with the help of an example for each. 5

- (d) Find the inverse of the function

$$f(x) = 3x + 5. \quad 3$$

4. (a) A taxi service charges an extra penalty based on distance from central point. The penalty is modelled by function $f(x) = |x - 4|$. Where, x is the distance in 'km' from the city start marker. Find Domain, Range, X-intercept, Y-intercept. Draw and interpret the graph. 8
- (b) A company increases an employee's salary every year by ₹ 2,000. If the starting salary is ₹ 20,000 per month, find the salary in the 10th year. Also, find the total salary received in the first 10 years. 6

- (c) A shopkeeper buys pens and notebooks, 2 pens and 1 notebook costs ₹ 50 whereas 1 pen and 2 notebooks costs ₹ 70. Find the cost of one pen and one notebook by using Cramer's rule. 6
5. (a) Suppose three resources x , y and z in a system satisfy the condition $x + y - z = 0$. Find a basis for the subspace of all vectors (x, y, z) satisfying this condition. 5
- (b) A company counts to create an access code using two different letters from the English alphabets followed by three different digits from 0 to 9. How many such access codes can be formed ? 5

- (c) A sensor output is modelled by $f(x) = |x - 3|$. Check whether the function is continuous at $x = 3$. 5
- (d) If $A = \begin{bmatrix} 3 & 5 \\ -2 & 4 \end{bmatrix}$, show that $\frac{1}{2}(A + A^T)$ is symmetric. 5

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