18417

BRAINWARE UNIVERSITY

Term End Examination 2025-2026
Programme – M.Tech.(CSE)-DS-2025
Course Name – Computational Mathematics for Data Science
Course Code - MTD10401
(Semester I)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) Select the necessary condition for a matrix to have an inverse.

a) It must be symmetric
b) It must be triangular
c) It must be square and of full rank
d) It must be diagonal

(ii) Select the condition for the determinant of a matrix to be zero.

a) The matrix is orthogonal
b) The matrix is singular
c) The matrix is symmetric
d) The matrix is diagonal

(iii) A system of equations has a unique solution if ____. Select the correct option.

a) The determinant is negative
b) The matrix is singular
c) The coefficient matrix is invertible
d) The rank is zero

(iv) If the mean of frequency distribution is 6.5 and ∑fi xi = 120 + 2k, ∑fi = 20, select k is equal to:

a)
b)

c) 10/25 d) 5/15

(v) In a deck of 52 cards, estimate the probability of drawing a heart card, given that it's a red card.

a) 1/2 b) 1/4
c) 1/13 d) 1/26

(vi) Identify the statement about the normal distribution that is true.

a) It is always positively skewed. b) It is always negatively skewed.
c) It is symmetric and bell-shaped. d) None of these

(vii) Choose the main goal of optimization.

a) Solve linear systems b) Compute determinants
c) Find eigenvalues d) Minimize or maximize a function

(viii) Choose the condition under which a function is convex.

a) It has multiple local minima b) Its gradient is always zero
c) The graph lies below any line segment between two points on the graph d) It is differentiable everywhere

(ix) Choose the use of Lagrange multipliers.

a) Estimate gradients b) Incorporate constraints into optimization
c) Compute eigenvalues d) Find determinants

(x) In simple linear regression, the slope coefficient represents _____. Select the correct option

a) Change in Y for a unit change in X b) Intercept
c) Standard error d) Correlation coefficient

(xi) Select the method that is commonly used for estimating the coefficients in linear regression

a) Maximum Likelihood b) Least Squares
c) Random Sampling d) Method of Moments

(xii) A curve of form $Y = ae^{bX}$ is best fitted using:

a) Polynomial regression b) Logistic regression
c) Nonlinear regression d) Linear regression

(xiii) The survival function gives _____. Choose the correct answer.

a) The hazard at time t b) The probability of surviving beyond time t
c) The expected lifetime d) The cumulative hazard

(xiv) K-means clustering minimizes _____. Select the correct answer.

a) Pairwise distances among all points b) Between-cluster variance only
c) Within-cluster sum of squares d) Total sample variance

(xv) A dendrogram is a visualization of _____. Select the correct answer.

a) PCA components b) Hierarchical clustering
c) MDS distances d) Kaplan-Meier survival curves

Group-B

(Short Answer Type Questions)

3 x 5=15

2. Enumerate the solution to the system of linear equations:
$2x - 6y + 7z = 1, 4y + 3z = 8, 2z = 4.$ (3)

3. Explain the axiomatic definition of probability. (3)

4. Compute the gradient of the univariate function (3)

$$f(x) = 5x^9 - 12x^6 + 4x^5 - 3x^2 + x - 2.$$

Gradient of a univariate function is its derivative.

5. In a trivariate distribution, if r_{12}=0.7, r_{13}=0.61 and r_{23}=0.4, enumerate all the multiple correlation coefficient. (3)

6. A covariance matrix has eigenvalue eigenvector pairs as follows: (3)

$$\lambda_1 = 100.16, e_1 = (0.040, 0.999)$$
$$\lambda_2 = 2.00, e_2 = (0.999, -0.040)$$

Write the principal components that can be used to explain most of the variance.

OR

Write a short note on multidimensional scaling. (3)

Group-C

(Long Answer Type Questions) 5 x 6=30

7. Write a short note on step-wise forward and backward selection for dimensionality reduction. (5)

8. If the vectors u, v, w are linearly independent, examine whether the vectors $u + v, u - v, u - 2v + w$ are also linearly independent. (5)

9. Write the point(s) on the curve $y = 1.5 - x^2$ closest to the origin via the Lagrange Multiplier method. (5)

10. Ten competitors in a musical contest were ranked by 3 judges A, B, C in the following order: (5)

Ranks by A	1	6	5	10	3	2	4	9	7	8
Ranks by B	3	5	8	4	7	10	2	1	6	9
Ranks by C	6	4	9	8	1	2	3	10	5	7

11. You are given the following data: (5)

	X	Y
Mean	36	85
Standard Deviation	11	8

If the Correlation coefficient between X and Y is 0.66, then Identify (i) the two regression coefficients, (ii) the most likely value of Y when X=10

12. A covariance matrix has eigenvalue eigenvector pairs as follows: (5)

$$\lambda_1 = 5.83, e_1 = (0.383, -0.924, 0)$$
$$\lambda_2 = 2.00, e_2 = (0,0,1)$$
$$\lambda_3 = 0.17, e_3 = (0.924, 0.383, 0)$$

Write the principal components that can be used to explain most of the variance.

OR

Consider a covariance matrix $\Sigma = \begin{pmatrix} 3 & 2 \\ 2 & 3 \end{pmatrix}$. Write the Principal Components and the percentage of variance explained by each. (5)

****