



44884

**BRAINWARE UNIVERSITY****Term End Examination 2025-2026****Programme – B.Tech.(CSE)-AIML-2025****Course Name – Essential Mathematics for Machine Learning****Course Code - BTA20101****(Semester II)**

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Kolkata, West Bengal-700125

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) Identify the correct option: Spectral decomposition is applicable for
 - a) Any square matrix
 - b) Real symmetric matrix
 - c) Singular matrix
 - d) Rectangular matrix
- (ii) Identify the correct option: Eigenvalues of a real symmetric matrix are
 - a) Complex
 - b) Real
 - c) Purely imaginary
 - d) Always zero
- (iii) The diagonal entries of Σ in SVD represent
 - a) Eigenvalues
 - b) Singular values
 - c) Determinants
 - d) Rank
- (iv) Identify the correct option: SVD is widely used in machine learning for
 - a) Data sorting
 - b) Dimensionality reduction
 - c) Matrix addition
 - d) Data labelling
- (v) Select the correct option: Truncated SVD is mainly applied to
 - a) Increase rank
 - b) Remove noise
 - c) Increase computation time
 - d) Find determinant
- (vi) Identify the correct option: Singular values are stored in the matrix
 - a) U
 - b) V
 - c) Σ
 - d) A^T
- (vii) Identify the correct option: LDA decision boundary is
 - a) Linear
 - b) Nonlinear
 - c) Quadratic
 - d) Random
- (viii) Write the focus of early optimization techniques.
 - a) Resource allocation
 - b) Complex algorithms
 - c) Artificial intelligence
 - d) Cost reduction

- (ix) Choose the correct one: In aerospace engineering, optimization techniques are primarily used for
- a) Maximizing fuel efficiency
 - b) Optimizing flight paths
 - c) Structural weight reduction
 - d) All of these
- (x) Choose the correct option. The objective function in an optimization problem represents
- a) A constraint
 - b) The quantity to be optimized
 - c) A constant value
 - d) None of these
- (xi) Choose the correct option . In an optimization problem, decision variables represent
- a) Constants
 - b) Fixed parameters
 - c) Variables to be determined
 - d) None of these
- (xii) Choose the correct option. A minimum norm solution is required if
- a) Maximum magnitude
 - b) Largest determinant
 - c) Maximum error
 - d) Smallest Euclidean norm
- (xiii) Choose the correct option. Multiple regression involves
- a) One predictor
 - b) One response
 - c) More than one independent variable
 - d) Only categorical data
- (xiv) Choose the correct option. Prior probability refers to
- a) Initial probability before evidence
 - b) Probability after experiment
 - c) Random probability
 - d) Conditional probability
- (xv) Choose the correct option. Bayes' theorem is widely used in
- a) Machine Learning classification
 - b) Geometry
 - c) Calculus
 - d) Graph theory

Group-B

(Short Answer Type Questions)

3 x 5=15

2. Using SVD, identify the rank of the matrix $A = \begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$. (3)
3. Let E and F are events of an experiment such that $P(E) = \frac{3}{10}$, $P(F) = \frac{1}{2}$ and $P(F|E) = \frac{2}{5}$. Calculate the value of $P(E \cap F)$ (3)
4. Consider the LP problem: (3)
- Maximize** $5X_1 + 6X_2$
- subject to**
- $X_1 + 2X_2 \leq 7$
- $3X_1 + 5X_2 \leq 13$
- $X_1, X_2 \geq 0$
- Write this into standard form.

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5. The covariance matrix of a dataset is $\begin{bmatrix} 5 & 0 \\ 0 & 2 \end{bmatrix}$. Identify the direction of the first principal component. (3)

6. Write the extreme values of the function $f(x, y) = x^2 + y^2 + (x + y + 1)^2$. (3)

OR

Construct the L.P.P in standard maximization form: (3)

$$\text{Min } z = x_1 + 5x_2 + 9x_3$$

Subject to

$$x_1 + 5x_2 + 2x_3 \leq 10$$

$$2x_1 + 6x_2 - 7x_3 \geq 20$$

$$4x_1 + 5x_3 = 50$$

$$2x_2 + 5x_3 \leq 80$$

for $x_1, x_2, x_3 \geq 0$.

Group-C

(Long Answer Type Questions)

5 x 6 = 30

7. Determine the extrema of the function $f(x, y) = x^3 + y^3 - 3x - 12y + 20$. (5)
8. Write advantages and disadvantages of Soft Margin SVM. (5)
9. Estimate the singular values of the matrix $\begin{pmatrix} 1 & 2 \\ 2 & 1 \end{pmatrix}$. (5)
10. Construct the best line $y = ax + b$ using least squares for data points $(1,1), (2,2), (3,2)$. (5)
11. Calculate the expectation of a random variable whose pdf is (5)

$$f(x) = \frac{1}{2}, 0 < x < 2.$$

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12. Use graphical method to solve the solution of the following L.P.P.

(5)

$$\text{Max } Z = 60x + 50y$$

Subject to,

$$x + 2y \leq 40$$

$$3x + 2y \leq 60$$

$$x, y \geq 0.$$

OR

Use the Lagrange multiplier method to solve the extrema of the function

(5)

$$f(x, y) = x^2 + 4y^2 \text{ subject to the constraint } x + 2y = 10.$$

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