# St. Xavier's College (Autonomous), Ahmedabad

**Syllabus of Semester – II of the following departments under Faculty of Data Science based on Undergraduate Curriculum Framework to be implemented from the Academic Year 2025-26.**

## DEPARTMENT OF DATA SCIENCE

### BSc. Artificial Intelligence and Machine Learning (Hons.)

## Minor Course: Introduction to Matrix Algebra

### CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course Title & Code | Credit Distribution of The Course | | | Eligibility Criteria | Prerequisite(s) of the Course (if any) |
|---|---|---|---|---|---|
| | Lecture | Tutorial | Practical / Practice | | |
| Calculus-1 | 4 | 0 | 0 | 10 + 2 from a recognized board in any stream | Basic Mathematics |

**Course Outcomes (COs)**

After successful completion of the course, students will be able to:

- CO-1: Apply matrix operations, determinants, and vector algebra in mathematical problem solving.
- CO-2: Compute matrix inverse, rank, and trace using standard algebraic methods.
- CO-3: Solve systems of linear equations using Gaussian and Gauss–Jordan elimination techniques.
- CO-4: Analyze eigenvalues, eigenvectors, orthogonality, and vector norms in the context of AI and ML applications.

**Learning Outcomes (LOs)**

At the end of the course, learners will be able to:

1. Explain different types of matrices, determinants, and vector operations with geometric interpretation.
2. Perform matrix computations including transpose, inverse, rank, and row reduction methods.
3. Represent and solve systems of linear equations using matrix techniques.
4. Compute eigenvalues, eigenvectors, vector projections, norms, and angles between vectors.

| UNIT | Topics / Subtopics | Hours |
|---|---|---|
| 1 | **Fundamentals of Matrices:** Definition of a matrix, order, and notation. Determinants of matrices: properties and computation. Geometric meaning of determinants, determinant as volume scaling factor, Types of matrices (restricted to real numbers): Row, column, square, diagonal, scalar, identity, zero. Symmetric, skew-symmetric. Upper triangular, lower triangular. Singular and non-singular matrices. Vectors: Column vector as a matrix. Addition, subtraction, scalar multiplication. Dot product and geometric interpretation | **15** |
| 2 | **Matrix Algebra and Computations:** Matrix addition, subtraction, multiplication. Matrix power and transpose. Inverse of a matrix (adjoint method, Gauss-Jordan method), Rank of a matrix: Definition and computation. Row echelon form and row-reduced echelon form, Trace of a matrix: definition, basic properties, relation to eigenvalues. | **15** |
| 3 | **Solving Systems of Linear Equations:** Linear equations in matrix form. Gaussian elimination method, Gauss-Jordan method. Solution cases: unique, infinite, no solution, Applications in AI and ML: expressing datasets as matrices. | **15** |
| 4 | **Eigenvalues, Eigenvectors, and Orthogonality:** Eigenvalues and eigenvectors: definition and computation, Properties of eigenvalues and eigenvectors, Orthogonal vectors and orthogonal matrices, Projection of one vector onto another, Norm of a vector (L1, L2, Euclidean norm), Angle between two vectors. | **15** |

Textbooks:

1. Practical Linear Algebra for Data Science by Mike X Cohen (O'Reilly Media)
2. Linear Algebra and Its Applications by David C. Lay

Reference Books:

1. Mathematics for machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press (2020)
2. Applied Linear Algebra by Peter J. Olver, Chehrzad Shakiban, Pearson (3rd Edn) 2018.