MATHEMATICAL FOUNDATIONS FOR COMPUTER SCIENCE

Subject Code: CS35112CS	**Subject Type:** DC	**Evaluation Scheme:** MSE (30), TA (20), ESE (50)	**L-T-P:** 3-0-0 (3)

Pre-Requisites: B.Tech. Level Mathematics

Course Objective: This course provides the essential mathematical foundation required for advanced studies in Computer Science and Engineering. It covers core areas such as linear algebra, probability, discrete mathematics, and optimization, with emphasis on their applications in computing domains including algorithms, data science, machine learning, networks, and systems.

Course Outcomes: At the end of the course, the student will be able to

CO	Course Outcomes
CO1	Apply linear algebra concepts for data representation and computational problems
CO2	Use probability and statistics to model uncertainty and analyze data-driven systems.
CO3	Analyze and apply discrete mathematical structures for algorithmic problem solving
CO4	Apply calculus and optimization techniques in computing and learning systems
CO5	Design computational solutions using mathematical reasoning and programming tools.

Syllabus:

Unit 1: Linear Algebra

Scalars, vectors, matrices (brief tensors), vector operations and geometric interpretation, norms (L1, L2), inner products, similarity and distance measures (Euclidean, cosine), matrix operations (transpose, rank, inverse), linear independence, basis, dimension (intuitive), linear transformations and projections, eigenvalues and eigenvectors, Singular Value Decomposition (SVD) with applications.

Unit 2: Probability & Statistics

Random variables (discrete and continuous), probability (joint, marginal, conditional), independence, distributions (Bernoulli, Binomial, Gaussian), expectation, variance, covariance, measures of central tendency and dispersion, correlation, Bayes theorem, parameter estimation (MLE), bias-variance tradeoff, hypothesis testing (concept), confidence intervals (intuition).

Unit 3: Discrete Structures & Computational Complexity

Logic and propositions, basic proof techniques, sets, relations, functions, graph theory fundamentals (representation, BFS/DFS concepts), combinatorics (basic counting principles), Recurrence relations and Master Theorem, asymptotic notation.

Unit 4: Calculus & Optimization

Functions of multiple variables, partial derivatives, gradients, chain rule, optimization concepts, gradient descent (basic idea), learning rate and convergence intuition, entropy and information measures (basic), cross-entropy and loss functions (conceptual), numerical stability.

Learning Resources:

Text Books:

1. Tivadar Danka, Mathematics of Machine Learning, Packt Publishing Ltd., 2025.
2. Deisenroth, M. P., Faisal, A. A. & Ong, C. S., Mathematics for Machine Learning, Cambridge University Press, 2020.
3. Boyd, S. & Vandenberghe, L., Convex Optimization, Cambridge University Press, 2004.
4. Rosen, K. H., Discrete Mathematics and Its Applications (8th ed.), McGraw-Hill, 2018.
5. Cormen, T. H. et al., Introduction to Algorithms (CLRS), 4th ed., MIT Press, 2022.

Reference Books:

1. Bishop, C. M., Pattern Recognition and Machine Learning, Springer, 2006.
2. Mitzenmacher, M. & Upfal, E., Probability and Computing, Cambridge University Press, 2017.
3. Sipser, M., Introduction to the Theory of Computation (3rd ed.), Cengage, 2012.
4. Stinson, D. & Paterson, M., Cryptography: Theory and Practice (4th ed.), CRC Press, 2019.