NIRMA UNIVERSITY

Institute:	Institute of Technology, School of Technology
Name of Programme:	MTech CSE
Course Code:	6CS205CC25
Course Title:	Applied Mathematics for Computer Science
Course Type:	Core
Year of Introduction:	2025-26

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Course Learning Outcomes (CLO):

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

1. explain the mathematical fundamentals related to sets, probability, statistics, and mathematical optimization (BL2)
2. apply the mathematical principles to solve a broad range of problems in computer science (BL3)
3. make use of mathematical concepts as per the need of the application (BL3)
4. interpret the role of statistical tests for real-time applications. (BL5)

Unit	Contents	Teaching Hours (Total 45)
Unit-I	**Probability:** Independence, Bayes Theorem, Discrete& Continuous Random Variables, Probability Mass and Density Functions, Cumulative Distribution Functions, Mean and Variance of a Random Variable, **Probability Distributions:** Discrete & Continuous Uniform Distribution, Binomial Distribution, Geometric and Negative Binomial Distributions, Hypergeometric Distributions, Poisson Distributions, Normal Distribution, Normal Approximation to the Binomial and Poisson Distributions, Exponential Distributions, Erlang and Gamma Distributions, Lognormal Distribution, Two or more Random Variables, Covariance and Correlation, Multinomial and Bivariate Normal Distributions, Hypothesis Testing	15
Unit-II	**Advanced Statistics:** Covariance and correlation, Confidence intervals, Correlation functions, Random walks, Markov chains, Hidden Markov Models, Statistical inference, Applications in Machine Learning, Gaussian Mixture Models	10
Unit-III	**Optimization:** Basic Concepts, Linear Programming, Duality, Constrained and unconstrained optimization, gradient decent and non-gradient techniques, Introduction to least squares optimization, optimization in Practice	10
Unit-IV	**Advanced topics:** Nonlinear dimensionality reduction methods, PCA in high dimensions and random matrix theory (Marcenko-Pastur),	10

Linear Discriminant Analysis, Matrix Factorization, Non-Negative Matrix Factorization, Proof Techniques, Random Graphs.

Self-Study:

The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Suggested Readings/ References:

1. Douglas C. Montgomery, George C. Runger, Applied Probability and Statistics for Engineers, Wiley
2. M. Mitzenmacher and E. Upfal, Probability and Computing: Randomized Algorithms and Probabilistic Analysis, Cambridge University Press
3. Sheldon Ross, A first course in Probability, Pearson
4. Cathy O'Neil and Rachel Schutt, Doing Data Science, O'Reilly Media
5. Avrim Blum, John Hopcroft, and Ravindran Kannan, Foundations of Data Science, e-book, Cornell University
6. Afonso S. Bandeira, Ten Lectures and Forty-Two Open Problems in the Mathematics of Data Science, e-book, MIT OCW
7. Jeff M. Phillips, Mathematical Foundations for Data Analysis, e-book, University of Utah
8. O. Paneerselvam, Operational Research, Prentice Hall.