Name of the programme	**: MSc. in Data Science**
Course code	**: CSD-504**
Title of the Course	**: Mathematics Foundation for Data Science (Theory)**
Number of Credits	**: 2 (2L-0T-0P)**
Total contact hours	**: 30 hours (30L-0T-0P)**
Effective from AY	**: 2023-24**

Pre-requisites for the course	Basic mathematics	
Course Objectives	1. To build a strong foundation in maths required for learning computer science/data science subjects. 2. To understand fundamental concepts and tools in calculus, linear algebra etc. with emphasis on their applications to computer science in particular data science/machine learning	
Content	**Unit1:** **Introduction** Importance of mathematics and their applications for computer science/machine learning/data science/deep learning Functions, variables, equations, graphs revision **Probability and Statistics:** Probability Rules & Axioms, Bayes' Theorem, Random Variables, Variance and Expectation, Conditional and Joint Distributions, Standard Distributions (Bernoulli, Binomial, Multinomial, Uniform and Gaussian), Moment Generating Functions, Maximum Likelihood Estimation (MLE), Prior and Posterior, Maximum a Posteriori Estimation (MAP) and Sampling Methods-confidence intervals, Hypothesis testing, p-values, A/B testing-ANOVA, t-test, Linear regression, regularization **Calculus** Overview of Differential and Integral Calculus, Partial Derivatives Product and chain rule-Taylor's series, infinite series summation/integration concepts-Fundamental and mean valuetheorems of integral calculus, evaluation of definite and improper integrals-Beta and Gamma functions, Functions of multiple variables, limit, continuity, partial derivativesBasics of ordinary and partial differential equations - Applications of Calculus	**15 hours**

	Unit 2: **Linear Algebra:** Systems of Linear Equations-Matrices-Solving Systems of Linear Equations-Vector Spaces-Linear Independence-Basis and RankLinear Mappings Affine Spaces **Analytic Geometry** Norms-(Inner Products-Lengths and Distances	**15 hours**
	Angles and Orthogonality-Orthonormal Basis Orthogonal Complement-Inner Product of Functions-Orthogonal Projections-Rotations) - Eigen value decomposition and SVD **Optimization** Differentiation of Univariate Functions-Partial Differentiation and Gradients-Gradients of Vector-Valued Functions-Gradients of Matrices Useful Identities for Computing Gradients-Backpropagation and Automatic Differentiation-Higher-Order Derivatives-Linearization and Multivariate Taylor Series-Gradient Descent-Constrained Optimization -Lagrange Multipliers-Convex Optimization,	
Pedagogy	Lectures/ Tutorials/Hands-on assignments/Self-study/Flipped classroom	
References/ Readings	1. Gel'fand, I. M., Glagoleva, E. G., & Shnol, E. E. E. (1990). Functions and graphs (Vol. 1). Springer Science & Business Media. 2. Lay, D. C. (2003). Linear algebra and its applications. Pearson Education India. 3. McClave, J. T., Benson, P. G., & Sincich, T. (2008). Statistics for business and economics. Pearson Education. 4. Sternstein, M. (2017). Barron's AP statistics. Simon and Schuster. 5. Strang, G. (2022). Introduction to linear algebra. Wellesley-Cambridge Press. 6. Wheelan, C. (2013). Naked statistics: Stripping the dread from the data. WW Norton & Company. 7. Witte, R. S., & Witte, J. S. (2017). Statistics. John Wiley & Sons.	

Course Outcomes	1. Strong understanding of mathematical concepts relevant to data science, including linear algebra, calculus, probability theory, and statistics. 2. Ability to apply mathematical principles to solve data science problems, such as dimensionality reduction, optimization, and uncertainty modeling. 3. Proficiency in mathematical modeling techniques and algorithms used in data science, such as regression, clustering, and classification. 4. Development of mathematical reasoning and problem-solving skills for analyzing and interpreting data, formulating mathematical solutions, and communicating results.

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