राष्ट्रीय प्रौद्योगिकी संस्थान पटना / NATIONAL INSTITUE OF TECHNOLOGY PATNA
संगणक विज्ञान एंव अभियांत्रिकी विभाग / DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
अशोक राजपथ, पटना-८००००५, बिहार / ASHOK RAJPATH, PATNA-800005, BIHAR
Phone No.: 0612-2372715, 2370419, 2370843, 2371929 Ext- 200, 202 Fax-0612-2670631 Website: www.nitp.ac.in

No:- Date:

CS011901 ***Mathematics for Data Science*** **L-T-P-Cr: 3-1-0-4**

Course Objective: The objective of the course is to familiarize with the basic mathematical concepts required for a data scientist like, Linear algebra, Analytic Geometry, Matrix Decompositions, Probability and Markov chain concepts.

Course Outcomes:
At the end of the course, a student will understand:

S.No	Course Outcome (CO)	Mapping to PO
1	Able to understand the Linear algebra and Analytic geometry concepts	PO1, PO2
2	Understand and apply the matrix decomposition concepts to data science domain	PO1, PO2
3	Demonstrate the basic mathematical concepts in data science relating to probability and calculus.	PO1, PO2, PO6
4	Understand the theory of stochastic processes, in particular Markov processes, and able to use markov processes in various areas of applications	PO1, PO2, PO6

UNIT-I Linear Algebra **Lectures 4**

Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces

UNIT-II Analytic Geometry **Lectures 3**

Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations

UNIT-III Matrix Decompositions **Lectures 5**

Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen Decomposition and Diagonalization, Singular Value Decomposition, Principal Component Analysis, Linear Discriminant Analysis, Matrix Approximation, Matrix Phylogeny

UNIT-IV Vector Calculus **Lectures 7**

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

UNIT-V Probability measures **Lectures 13**

Elementary probability, Basic facts, Events, Probability measures, Continuity of measures, Integral with respect to a measure, Probabilities on finite and denumerable sets, Probabilities on denumerable sets, Probabilities on uncountable sets, Conditional probability, Bayes formula, Random variables, Random variables, Expected value, Functions of random variables, Variance, Markov and Chebyshev inequalities, A few discrete distributions, Bernoulli distribution, Binomial distribution, Hypergeometric distribution, Poisson distribution, Geometric distribution.

UNIT-VI Discrete Time Markov chains: **Lectures 06**

Stochastic matrices, Oriented graphs, Markov chains, Stochastic processes, Transition matrices, Homogeneous processes, Markov chains, Canonical Markov chains, Some characteristic parameters, Steps for a first visit, Probability of (at least) r visits, Recurrent and transient states, Mean first passage time, Hitting time and hitting probabilities.

UNIT-VII MATHEMATICS IN INDIA:
Lectures 04

Origins: Vedas and Śulbasūtras—Place value system, Conception of zero, Origins of geometry; Overview of important mathematical texts and the contributions of leading Indian mathematicians—Āryabhaṭīya of Āryabhaṭa, Brāhmasphuṭasiddhānta of Brahmagupta, Līlāvatī and Bījagaṇita of Bhāskarācārya.

Text Books:

1. Mathematics For Machine Learning by Deisenroth Marc Peter , Faisal A Aldo and Ong Cheng Soon (Cambridge University press, 2021).
2. A First Course in Probability and Markov Chains by Giuseppe Modica, Laura Poggiolini, Wiley publication.
3. The Science of the Śulba, B. Datta, University of Calcutta, 1932.
4. Āryabhaṭīya of Āryabhaṭa, K. S. Shukla and K. V. Sarma, Indian National Science Academy, 1976.
5. Līlāvatī of Bhāskarācārya, H. T. Colebrooke, ed. by H. C. Banerji, Kitab Mahal, 1967.