St. Xavier's College (Autonomous), Ahmedabad

Syllabus of Semester – III of the following departments under Faculty of Data Science based on Undergraduate Curriculum Framework to be implemented from the Academic Year 2026-27.

DEPARTMENT OF DATA SCIENCE

Category II
BSc. Artificial Intelligence and Machine Learning (Hons.)

Multi-Disciplinary Course-3: Probability for Data Science

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		
Probability for Data Science	4	0	0	10 + 2 from a recognized board in any stream	Nil

Course Outcomes:

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

CO1: Apply the fundamental concepts of probability, counting techniques, conditional probability, and Bayes' theorem to model uncertainty and support decision-making in AI and Machine Learning applications.
CO2: Analyze discrete probability distributions and random variables using measures such as expectation, variance, and generating functions, and simulate random data from common discrete probability models.
CO3: Evaluate continuous probability distributions and their properties, and generate random samples from standard continuous probability models used in data analysis and machine learning.
CO4: Apply probabilistic inequalities and bivariate probability models to analyze relationships between random variables and solve problems involving joint, marginal, and conditional probability distributions.

Learning Outcomes:

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

- Explain the fundamental concepts of probability, including sample spaces, events, probability axioms, conditional probability, independence, and Bayes' theorem.
- Describe discrete and continuous random variables and their associated probability distributions.
- Analyze and apply common discrete and continuous probability distributions such as Bernoulli, Binomial, Poisson, and Geometric, Uniform, Exponential, and Normal distributions.

- Generate and interpret random samples from standard probability distributions using computational tools.
- Utilize probability generating functions, moment generating functions, and characteristic functions to study random variables.
- Apply probabilistic inequalities such as Markov's, Chebyshev's, and Jensen's inequalities in uncertainty analysis.
- Analyze bivariate probability models and determine joint, marginal, and conditional probability distributions for discrete random variables.
- Evaluate relationships between random variables and assess probabilistic dependence and independence.
- Employ probabilistic reasoning concepts in the analysis of uncertainty arising in Artificial Intelligence and Machine Learning applications.

UNIT	TOPICS / SUBTOPICS	HOURS
1	**Basic Probability Theory:** Sets and counting, Random experiment, sample space, events, axioms of probability, properties, addition theorem on two and three events, conditional probability, multiplication theorem, statistical independence, Bayes' theorem, Need of probabilistic reasoning in AI, Applications.	15
2	**Discrete Random Variables and Probability Models:** Discrete random variables, probability mass functions (pmf), expectation, variance and standard deviation of a random variable, Probability Generating Function, Moment Generating Function and Characteristic Function (only definition and properties (without proof), Bernoulli, binomial, Poisson and geometric probability models and their random number generations.	15
3	**Continuous Random Variables and Probability Models:** Continuous random variables, probability density function, expectation, variance and standard deviation of a random variable, Uniform, exponential and normal probability models and their random number generations.	15
4	**Probabilistic Inequalities and Bivariate Probability Models:** Markov and Tchebycheff inequality, functions of random variables, Jensen's inequality, bi-variate random variable, joint probability models, marginal and conditional probability models (only for discrete random variables)	15

Textbooks:

1. Ross, Sheldon M. (2019). *A First Course in Probability* (10th Edition). Pearson Education.

2. Stanley H Chan (2021). *Introduction to probability for Data Science*. Michigan Publishing

Reference Book:

1. Michael Baron (2014). *Probability and Statistics for Computer Scientists* (2nd edition), CRC Press, Taylor and Francis.