

<b>COURSE TITLE</b>	<b>APPLIED PROBABILITY AND STATISTICS</b>
<b>COURSE CODE</b>	<b>01AS0302</b>
<b>COURSE CREDITS</b>	<b>4</b>

**Objective:**

- 1 This course aims to develop a strong foundation in probability theory and statistical methods essential for data science and AI. It enables students to understand random variables, probability distributions, and inferential concepts, and to apply these techniques for modeling uncertainty, analyzing data, and solving real-world problems using computational tools.

**Course Outcomes:** After completion of this course, student will be able to:

- 1 Understand fundamental concepts of probability, events, and random variables. (Understand & Remember)
- 2 Apply probability laws and distributions to solve real-world problems. ( Evaluate & Apply)
- 3 Understand the concept of discrete and continuous probability distributions and interpret their behaviour. (Understand & Evaluate )
- 4 Develop probabilistic models and computational solutions for data-driven applications. (Apply & Analyse)

**Pre-requisite of course:**Basic Mathematics, Basic Programming

**Teaching and Examination Scheme**

<b>Theory Hours</b>	<b>Tutorial Hours</b>	<b>Practical Hours</b>	<b>ESE</b>	<b>IA</b>	<b>CSE</b>	<b>Viva</b>	<b>Term Work</b>
3	0	2	50	30	20	25	25

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
1	<b>Fundamentals of Probability Theory</b> Understand the Random experiment, Trial, Sample point and Sample space, Events, Operations of events, Concept of equally likely, Mutually exclusive and Exhaustive events, Definition of Probability: Classical, Relative frequency and Axiomatic approaches, Properties of probability, Conditional probability, Total and Compound Probability theorems, Bayes' theorem and independence	10
2	<b>Random Variables and Probability Distributions</b> Generate the Random Variables using Discrete and Continuous, Probability Mass Function (pmf), Probability density function (pdf) and Cumulative distribution function (cdf), Joint distribution of two random variables, Marginal and Conditional distributions, Independence of random variables, Expectation of a random variable and its properties, Expectation of sum of random variables and product of independent random variables	11

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
3	<b>Limit Theorems and Inequalities</b> Demonstrate the Chebyshev's inequality with related problems, Weak law of large numbers for a sequence of independently, identically distributed random variables and their applications (Statement Only).	6
4	<b>Discrete Probability Distributions</b> Study with examples and applications of Bernoulli, Binomial, Poisson, Geometric distributions with their means and variances, Various important properties related to these distributions including truncated and compound	9
5	<b>Continuous Probability Distributions</b> Apply and analyse different distribution like exponential, Gamma, Weibul, Beta, Normal distribution Their means, Variances using numerical examples	9
<b>Total Hours</b>		<b>45</b>

#### Suggested List of Experiments:

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
1	<b>Practical 1</b> Perform basic probability operations and set operations for events using R.	2
2	<b>Practical 2</b> Compute classical, conditional and compound probabilities using R.	2
3	<b>Practical 3</b> Apply Bayes' theorem and verify independence of events using R.	2
4	<b>Practical 4</b> Generate and analyze discrete random variables and their probability mass functions.	2
5	<b>Practical 5</b> Generate and analyze continuous random variables and their probability density functions.	2
6	<b>Practical 6</b> Construct and visualize cumulative distribution functions for random variables.	2
7	<b>Practical 7</b> Compute joint, marginal and conditional distributions using R.	2
8	<b>Practical 8</b> Evaluate expectation and properties of random variables using R.	2
9	<b>Practical 9</b> Generate and analyze Bernoulli, Binomial and Geometric distributions in R.	2
10	<b>Practical 10</b> Generate and study Poisson distribution and its applications using R.	2

### Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
11	<b>Practical 11</b> Implement and analyze Exponential, Gamma and Weibull distributions using R.	2
12	<b>Practical 12</b> Generate and study Beta and Normal distributions using graphical and numerical methods.	2
13	<b>Practical 13</b> Perform comparative analysis of discrete and continuous probability distributions using R.	2
14	<b>Practical 14</b> Mini Project: End-to-end probabilistic data analysis using real datasetLabs	2
<b>Total Hours</b>		<b>28</b>

### Textbook :

- 1 An Introduction to Statistical Learning with Applications in R, G. James, D. Witten, T. Hastie, R. Tibshirani, Springer, 2021
- 2 Fundamentals of Mathematical Statistics, S.C. Gupta & V.K. Kapoor, Sultan Chand & Sons, 2020
- 3 Probability and Statistics for Engineers and Scientists, Ronald E. Walpole, Raymond H. Myers, C. Montgomery & George C. Runger, Pearson, 2016
- 4 Introductory Statistics with R, Peter Dalgaard, Springer, 2008
- 5 Statistics for Data Science, James D. Miller, Packt Publishing, 2017

### References:

- 1 R in Action: Data Analysis and Graphics with R, R in Action: Data Analysis and Graphics with R, Robert Kabacoff, Manning Publications, 2022
- 2 The Art of R Programming, The Art of R Programming, Norman Matloff, No Starch Press, 2011
- 3 Applied Statistics and Probability for Engineers, Applied Statistics and Probability for Engineers, Douglas C. Montgomery, Wiley, 2018
- 4 All of Statistics, All of Statistics, Larry Wasserman, Springer, 2004

### Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
15.00	25.00	30.00	20.00	10.00	0.00

**Instructional Method:**

- 1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.
- 2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
- 3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
- 4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses.

**Supplementary Resources:**

- 1 <http://mathworld.wolfram.com>
- 2 <http://en.wikipedia.org/wiki/Math>
- 3 <https://pll.harvard.edu/course/statistics-and-r>