DEPARTMENT OF INFORMATION TECHNOLOGY
NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA SURATHKAL

COURSE PLAN(IT302): Probability and Statistics (AUG'23-DEC'23)

Course Code:	IT302	**Course Name:**	Probability and Statistics
Core/Elective/ MLC	Core	**Credits (L-T-P)**	(3-0-2) 4
Pre-requisites:	Set Theory, Calculus, Algebra, Mathematical Logic	**Contact Hours**	9AM to 5 PM
Type of Course: (Lecture/Tutorial/ Seminar/Project)	Lecture/Project	**Course Assessment Methods: (Both Continuous and Semester-End Assessment)**	**Theory: 60%** **Practical: 40%** Mid-sem Examination: 20% End-sem Examination: 40% Lab Assignments: 20% Project: 20%

Course Description:

This comprehensive course introduces students to the fundamental principles of probability theory and statistics while emphasizing their practical applications across various domains. Beginning with an exploration of basic statistical concepts, students will delve into the intricacies of probability theory, random variables, statistical distributions, stochastic processes, queuing systems, sampling theory, and hypothesis testing. By the course's end, students will possess a robust understanding of statistical analysis and its role in making informed decisions.

The course commences with an "Introduction to Statistics and Data Analysis," providing students with a solid grounding in the essentials of data collection, representation, and interpretation. It lays the foundation for subsequent topics.

Probability theory takes center stage, where students will learn about non-deterministic models, finite probability spaces, conditional probability, and the principles of independence and mutual exclusivity. The exploration continues with an in-depth examination of Bayes' Theorem, which is a crucial tool for understanding probabilistic relationships.

Students will then progress to the realm of random variables, including both one-dimensional and two-dimensional cases. They will explore concepts of expectation and variance, critical for quantifying uncertainty in data.

The course further investigates a range of statistical distributions, including the Uniform, Normal, Binomial, Gamma, Exponential, Poisson, Chi-Square, and Log-Normal distributions. These distributions find application in modeling various real-world phenomena.

Stochastic processes, with a specific focus on Markov Chains, Binomial, and Poisson processes, offer insights into dynamic systems and their probabilistic behavior.

Queuing systems, specifically M/M/1 and M/M/K models, will be studied in-depth, providing students with the tools to analyze waiting time and service processes in diverse scenarios.

Sampling theory introduces the principles of random sampling and its practical applications. Students will learn to compute measures of central tendency, variability, and dispersion, including mean, median, mode, variance, and standard deviation.

Finally, the course explores hypothesis testing, guiding students through the formulation of null and alternate hypotheses, the selection of parametric and non-parametric tests, criteria for hypothesis acceptance, and the concept of the level of significance. Students will apply their knowledge by conducting t-tests, z-tests, and Chi-Square tests in various real-world scenarios.

This course equips students with the statistical and probabilistic tools necessary to analyze data, make informed decisions, and solve complex problems in diverse fields, including business, engineering, healthcare, and the sciences. It prepares them to navigate the data-driven landscape of the modern world.

Course Objectives:

1. Develop Fundamental Knowledge: Provide students with a solid foundation in the principles of probability theory and statistics, ensuring they understand the core concepts and mathematical underpinnings.

2. Understand Probability Concepts: Familiarize students with essential probability concepts, such as conditional probability, independence, and Bayes' Theorem, allowing them to model and solve probabilistic problems.

3. Apply Statistical Techniques: Enable students to apply a variety of statistical techniques, including probability calculations, hypothesis testing, and data analysis, to solve real-world problems and make informed decisions.

4. Analyze and Interpret Data: Equip students with the skills to collect, organize, and critically analyze data, as well as interpret the results within the context of specific applications and scenarios.

5. Explore Statistical Distributions: Introduce students to a range of statistical distributions, including the Normal, Binomial, Poisson, and Exponential distributions, enabling them to model various data types and phenomena.

6. Examine Stochastic Processes: Provide insights into stochastic processes, particularly Markov Chains, Binomial processes, and Poisson processes, and their role in modeling dynamic systems.

7. Analyze Queuing Systems: Enable students to analyze queuing systems, such as M/M/1 and M/M/K models, to understand waiting time and service processes in diverse practical applications.

8. Master Sampling Theory: Familiarize students with random sampling techniques, and help them understand the applications of sampling theory in estimating population parameters and making inferences.

9. Perform Hypothesis Testing: Equip students with the knowledge and skills to formulate hypotheses, select appropriate parametric and non-parametric tests, set levels of significance, and make sound decisions based on hypothesis testing results.

10. Apply Statistical Software: Introduce students to statistical software tools or programming languages commonly used in data analysis, allowing them to apply statistical methods in practice.

11. Develop Critical Thinking: Cultivate critical thinking skills by challenging students to evaluate and critique statistical studies, research designs, and data interpretation critically.

12. Solve Real-World Problems: Encourage students to apply their statistical knowledge to solve real-world problems in various fields, including business, science, engineering, and social sciences.

These course objectives aim to provide students with a well-rounded understanding of probability and statistics, preparing them to apply statistical techniques effectively in both academic and practical settings.

Course outcomes (COs):

1. CO1: Fundamental Statistical Proficiency
Develop a strong foundation in statistical principles and concepts, including probability theory, random variables, and statistical distributions, enabling students to conduct data analysis and probability modeling effectively.

2. CO2: Analytical Problem-Solving Skills
Cultivate analytical problem-solving skills, allowing students to apply statistical techniques to a wide range of real-world scenarios, make informed decisions, and interpret results accurately.

3. CO3: Advanced Probability and Stochastic Understanding
Gain an advanced understanding of probability theory and stochastic processes, including conditional probability, independence, Markov Chains, and queuing systems, enabling students to model complex dynamic systems.

4. CO4: Practical Data Analysis and Interpretation
Develop practical data analysis skills, including data collection, organization, and interpretation. Students will master hypothesis testing, sampling theory, and the use of statistical software tools to solve practical problems in diverse fields.

These course outcomes encompass the core content of the syllabus, align with the course description, and reflect the overarching objectives of the course. They aim to prepare students with a robust understanding of probability theory and statistics and the ability to apply these principles effectively in real-world applications.

Detailed Course Plan:

Week 1	Introduction to Statistics and Data Analysis; Introduction to Probability Theory
Week 2 & 3	**Probability Theory:** Non-deterministic models, Finite Probability Space and related concepts, Conditional Probability, Independent and mutually exclusive events, Bayes' Theorem
Week 4 & 5	**Random Variables:** One and Two dimensional, Expectation, Variance, Correlation
Week 6 & 7	**Statistical Distributions:** Uniform, Normal, Binomial, Gamma, Exponential, Poisson, Chi-Square, Log-Normal
Week 8, 9 & 10	**Stochastic Processes:** Markov Chains, Binomial & Poisson**; Queuing Systems:** M/M/1 and M/M/K
Week 11	**Sampling Theory:** Random Sampling and Applications, Mean, Median, Mode, Variance, Standard Deviation
Week 12, 13 & 14	**Hypothesis Testing:** Formulation of hypothesis - null and alternate hypothesis, Parametric and non-parametric tests and their applicability, Criteria for acceptance of hypothesis, Level of Significance, t-test, z-test and Chi-Square Tests with applications.

References:

1. P. L. Meyer, Introductory Probability and Statistical Applications, Oxford & IBH Publishers, 2017.
2. S. M. Ross, Introduction to Probability & Statistics for Engineers and Scientists, 5th Ed., Academic Press, 2014.
3. Michael Baron, Probability and Statistics for Computer Scientists, 2nd Edition, CRC Press, 2014.
4. R. V. Hogg, J. W. McKean and A. T. Craig, Introduction to Mathematical Statistics, 7th Edition, Pearson, 2012.

5. R. E. Walpole et al., Probability and Statistics for Engineers and Scientists, 9th Edition, Pearson, 2010.
6. Jane M. Horgan, Probability with R with Computer Science Applications, 1st Edition, John Wiley, 2009.
7. John Verzani, Using R for Introductory Statistics, 2nd Edition, CRC Press, 2014.
8. G. Jay Kerns, Introduction to Probability and Statistics Using R, 1st Edition, G. Jay Kerns, 2010.
9. Maria Dolores Ugarte et al., Probability and Statistics with R, 2nd Edition, CRC Press, 2015.

Course instructor:

Mr. Palla Parasuram Yadav

Mentor:

Dr. Anand Kumar M