National University of Engineering (UNI)
School of Computer Science
Syllabus 2026-I

1. COURSE

STA251. Probability Calculation (Mandatory)

2. GENERAL INFORMATION

2.1 Course	:	STA251. Probability Calculation
2.2 Semester	:	3^{rd} Semester.
2.3 Credits	:	3
2.4 Hours	:	2 HT; 2 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Mandatory
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	BMA102. Differential Calculus. (1^{st} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Probability and statistics are fundamental in computer science for algorithm analysis, system modeling, decision-making under uncertainty, and data analysis. This course integrates probability theory with statistical methods, focusing on computational applications such as algorithm analysis, machine learning, system modeling, and data science.

5. GOALS

- Understand the fundamentals of probability and statistical inference.
- Apply probability distributions and statistical methods to solve computing problems.
- Develop skills for modeling stochastic systems and performing data inference.

6. COMPETENCES

AG-C07) Computing Knowledge: Applies knowledge of mathematics, science, and computing. (Familiarity)

7. TOPICS

Unit 1: Probability Fundamentals (6 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• Probability spaces and axioms • Event operations: union, intersection, complement • Counting techniques: permutations and combinations • Conditional probability and independence • Bayes' theorem and applications	• Define sample spaces and apply probability axioms. [Familiarizarse] • Use counting techniques to calculate probabilities. [Usar] • Apply Bayes' theorem in classification problems. [Evaluar]
Readings : [Ros14], [Dev16]	

Unit 2: Discrete Random Variables (6 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• Discrete random variables • Probability mass function (PMF) and cumulative distribution function (CDF) • Expectation, variance, and moments • Distributions: Bernoulli, Binomial, Geometric, Poisson • Applications in computational system modeling	• Define and characterize discrete random variables. [Familiarizarse] • Calculate expectation and variance for different distributions. [Usar] • Apply discrete distributions in network and system modeling. [Evaluar]
Readings : [Ros14], [Dev16]	

Unit 3: Continuous Random Variables (6 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• Continuous random variables • Probability density function (PDF) and CDF • Transformations of random variables • Distributions: Uniform, Exponential, Normal • Applications in system simulation and queuing theory	• Differentiate between discrete and continuous variables. [Familiarizarse] • Calculate probabilities using density functions. [Usar] • Model service times and arrival times using continuous distributions. [Evaluar]
Readings : [Ros14], [Dev16]	

Unit 4: Multivariate Distributions and Dependence (6 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• Joint and marginal distributions • Conditional distributions • Covariance and correlation • Independence of random variables • Applications in multidimensional data analysis	• Calculate joint and marginal distributions. [Familiarizarse] • Measure dependence using covariance and correlation. [Usar] • Analyze relationships between variables in datasets. [Evaluar]
Readings : [Ros14], [Dev16]	

Unit 5: Limit Theorems and Approximations (6 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• Law of Large Numbers • Central Limit Theorem • Moments and generating functions • Probabilistic inequalities (Chernoff, Markov, Chebyshev) • Applications in big data and algorithm analysis	• State and interpret limit theorems. [Familiarizarse] • Apply CLT in distribution approximations. [Usar] • Use inequalities in algorithm bound analysis. [Evaluar]
Readings : [Ros14], [Dev16]	

Unit 6: Bayesian Inference (6 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• Bayesian updating with discrete/continuous priors • Maximum A Posteriori (MAP) estimation • Bayesian credible intervals • Conjugate priors • Applications in Naive Bayes classifiers and ML	• Differentiate between frequentist and Bayesian approaches. [Familiarizarse] • Perform Bayesian belief updating. [Usar] • Implement MAP estimation in machine learning problems. [Evaluar]
Readings : [Ros14], [Dev16]	

Unit 7: Statistical Inference (6 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• Parameter estimation: MLE (Maximum Likelihood Estimation) • Hypothesis testing: z-test, t-test, chi-square test • Confidence intervals • Bootstrapping and resampling methods • Applications in model validation and data science	• Estimate parameters using maximum likelihood methods. [Familiarizarse] • Perform hypothesis testing to validate assumptions. [Usar] • Construct confidence intervals and apply bootstrapping. [Evaluar]
Readings : [Dev16]	

Unit 8: Regression and Advanced Applications (6 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• Simple linear regression • Least squares fitting • Poisson processes • Monte Carlo simulation • Introduction to Markov chains • Applications in prediction and system modeling	• Implement linear regression models. [Familiarizarse] • Use Monte Carlo simulation to solve complex problems. [Usar] • Apply stochastic processes in real system modeling. [Evaluar]
Readings : [Dev16]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

********* EVALUATION MISSING ********

10. BASIC BIBLIOGRAPHY

[Ros14] Sheldon M. Ross. *A First Course in Probability*. Pearson, 2014.

[Dev16] Jay L. Devore. *Probability and Statistics for Engineering and the Sciences*. Cengage Learning, 2016.