NATIONAL UNIVERSITY OF SAN MARCOS

FACULTY OF MATHEMATICAL SCIENCES

SYLLABUS

1. GENERAL INFORMATION

1.1 Course name	:	Stochastic processes
1.2 Code	:	MA352
1.3 Academic Program	:	Scientific Computing
1.4 Credits	:	5
1.5 Prerrequisites	:	• MA351. Statistics and Probabilities. (6^{th} Sem) • MA210. Calculus III. (4^{th} Sem) • CS261. Artificial Intelligence. (7^{th} Sem)
1.6 Type of Course	:	Elective
1.7 Area of Studies	:	Estudios Generales
1.8 Number of Weeks	:	16
1.9 Hours per week	:	3 HT; 4 HP;
1.10 Cycle	:	I
1.11 Learning modality	:	Face to face
1.12 Academic Period	:	2026-I
1.13 Semester Start Date	:	
1.14 Semester End Date	:	

2. PROFESSORS

Meetings after coordination with the professor

3. INTRODUCTION TO THE COURSE

This course introduces the theory of stochastic processes, providing mathematical foundations for the study of systems that evolve randomly over time. It develops skills for modeling random phenomena in finance, engineering, and sciences through Markov chains, Poisson processes, and Brownian motion, with applications in simulation and analysis of stochastic systems.

4. GOALS

- Understand fundamental concepts of stochastic processes
- Model systems using discrete and continuous time Markov chains
- Analyze Poisson processes and their applications
- Apply stochastic processes to problems in finance and sciences

5. COMPETENCES

ABET-1) An ability to identify, formulate, and solve broadly defined technical or scientific problems by applying knowledge of mathematics and science and/or technical topics to areas relevant to the discipline. (Usage)

ABET-3) An ability to develop and conduct experiments or test hypotheses, analyze and interpret data, and use scientific judgment to draw conclusions. (Usage)

6. TOPICS

Unit 1: Advanced Probability and Stochastic Processes (20 hours)	
Competences Expected: ABET-1,ABET-3	
Topics	**Learning Outcomes**
• Measure-theoretic probability foundations • Random variables and distributions • Stochastic processes characterization • Markov chains and Markov processes • Brownian motion and diffusion processes	• Apply measure-theoretic concepts to probability spaces [Familiarity] • Characterize different types of stochastic processes [Assessment] • Analyze Markov chains for steady-state and transient behavior [Usage] • Model systems using continuous-time stochastic processes [Usage]
Readings : [**Ross2019**], [**Karlin2014**]	

Unit 2: Discrete Systems Simulation (20 hours)	
Competences Expected: ABET-1,ABET-3	
Topics	**Learning Outcomes**
• Queueing theory and models • Cellular automata and agent-based models • Monte Carlo simulation methods • Markov chains and processes • Discrete-event simulation	• Formulate and analyze simple queueing models [Usage] • Implement cellular automata and agent-based simulations [Usage] • Apply Monte Carlo methods for probabilistic simulation [Usage] • Analyze Markov chains for state transitions and steady-state behavior [Assessment] • Design discrete-event simulations for system analysis [Usage]
Readings : [**Ross2019**], [**Karlin2014**]	

Unit 3: Computational Statistical Inference (20 hours)	
Competences Expected: ABET-1,ABET-3	
Topics	**Learning Outcomes**
• Maximum Likelihood Estimation (MLE) • Bayesian inference methods • Markov Chain Monte Carlo (MCMC) methods • Expectation-Maximization (EM) algorithm • Bootstrap and jackknife resampling	• Implement Maximum Likelihood Estimation for various distributions [Usage] • Apply Bayesian methods for parameter estimation [Usage] • Implement MCMC algorithms for posterior sampling [Usage] • Use EM algorithm for models with latent variables [Usage] • Apply bootstrap methods for confidence intervals [Usage]
Readings : [**Ross2019**], [**Karlin2014**]	

Unit 4: Continuous Systems Simulation (20 hours)	
Competences Expected: ABET-1,ABET-3	
Topics	**Learning Outcomes**
• Ordinary Differential Equations (ODEs) models • Partial Differential Equations (PDEs) models • Finite difference methods for PDEs • Solver selection and implementation • Stiff systems and adaptive methods	• Formulate ODE and PDE models for physical systems [Usage] • Implement finite difference methods for simple PDEs [Usage] • Select appropriate numerical solvers for different types of ODEs/PDEs [Assessment] • Handle stiff systems using appropriate numerical methods [Usage]
Readings : [**Ross2019**], [**Karlin2014**]	

7. WORKPLAN

7.1 Methodology

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

7.2 Theory Sessions

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

7.3 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.

8. EVALUATION SYSTEM

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

9. BASIC BIBLIOGRAPHY