University of Pavia

IUSS School of Advanced Studies

Civil Engineering for Mitigation of Risk from Natural Hazards

Course: Probability and Statistics for Engineering Applications

a.y.: 2025/2026
Lecturers: Prof. Paolo Bazzurro, Prof. Enrico Creaco; Dr. Carlo Giudicianni
Date: 07/01/2026 – 30/01/2026
Classroom: See time schedule below for details

COURSE SCHEDULE

						lectures	tutorials	exam
Week	Date	Lecture hours From___ To___	Classroom	Tutorial hours From___To____	Classroom	Tot h		
	05-Jan							
	06-Jan							
1	07-Jan	9:00-13:00	Broletto - 1.15			4		
	08-Jan	9:00-13:00	Broletto - 1.17			4		
	09-Jan	9:00-13:00	Broletto - 1.15	15:00-18:00	Aula Ricciardi (DICAr)	4	3	
	12-Jan	9:30-12:30	Broletto - Sala Riunioni			3		
	13-Jan	9:30-12:30	Broletto - 1.17	14:00-17:00	Aula Ricciardi (DICAr)	3	3	
2	14-Jan	9:30-12:30	Broletto - 1.17	14:00-17:00	Aula Ricciardi (DICAr)	3	3	
	15-Jan							
	16-Jan			14:00-17:00	Aula Ricciardi (DICAr)		3	
	19-Jan							
	20-Jan	9:00-13:00	Broletto - 1.16	15:00-18:00	Aula Ricciardi (DICAr)	4	3	
3	21-Jan	9:30-12:30	Broletto - 1.15			3		
	22-Jan	9:30-12:30	Broletto - 1.15	14:00-17:00	Aula Ricciardi (DICAr)	3	3	
	23-Jan	9:30-12:30	Broletto - 1.15			3		
	26-Jan			14:00-16:00	Aula Ricciardi (DICAr)		2	
	27-Jan			14:00-17:00	Aula Ricciardi (DICAr)		3	
4	28-Jan							
	29-Jan	9:00-12:00 final exam	tbd					3
	30-Jan							

OBJECTIVES

Many problems in Civil Engineering cannot be fully or efficiently addressed without a solid understanding of probability and statistics. In this course, we aim to cover the fundamental concepts of probability and statistics relevant to practical applications, minimizing discussions on topics like dice tossing and card games. Rather than focusing on derivations, we will emphasize concepts and real-world applications. We will begin by exploring how probability and statistics are related but distinct, followed by an introduction to random variables and functions of random variables. Next, we will delve into probability distribution functions commonly used in civil engineering. Towards the latter part of the course, we will discuss statistics and sampling, including topics such as goodness-of-fit tests, regression analysis, parameter estimation, and hypothesis testing. We will also introduce the basics of Monte Carlo simulation and variance reduction techniques.

Each topic will be linked to practical problems and solutions across various civil engineering disciplines, including Structural, Earthquake, Transportation, Water Resources and Environmental, and Geotechnical Engineering. Basic decision analysis applications will also be introduced.

The course will be conducted in English.

DESCRIPTION

Theoretical lectures will be supplemented with tutorials, focusing on the practical application of the concepts and methods introduced during the lectures. The topics covered in the course are outlined below:

COURSE CONTENTS:

PART I

- Overview of the course. Why do we need probability and statistics? Fundamentals of Applied Probability and Statistics
- Main Objectives of the Course
- Probability and Statistics. Why Bother? Do you have a good number sense?
- Looking ahead: Examples of use of probability and Statistics to model occurrences of natural events

PART II

- Fundamentals of Applied Probability and Statistics
- Set Theory and Probability Theory
- Random Variables and Distributions
- Jointly Distributed Random Variables
- Expectations and Moments of Random variables
- Functions of Random Variables
- Using Empirical Data
- Common Probability Distribution Models:
- Models for Repeated Experiments
- Models for Random Occurrences
- Limiting Cases: the Normal Distribution, the Lognormal Distribution, the Extreme Value Distributions
- Uniform and Beta distributions

PART III

- Monte Carlo Simulation
- Brute-force Monte Carlo simulation
- Variance-reduction techniques

PART IV

- Overview of Applied Classical Statistics:
- Distribution Parameter Estimation
- Random Variable Model Selection
- Goodness of fit tests
- Basics of Linear Regression Analysis
- Hypothesis testing

REQUIREMENTS

Knowledge of college-level calculus and basic skills in at least one of the following computer SW tools: Excel, Matlab, R. Proficiency in reading, writing and comprehending English language. Examples from different branches of engineering will be used throughout the course, but no prior in-depth knowledge of engineering is necessary.

REFERENCES

Handouts, scientific papers and other technical materials made available during the course.
Although not required, the following books may prove to be very useful for the course and as future reference after the course

- Ang, A. H. and Tang, W. H. (2007). "Probability Concepts In Engineering: Emphasis On Applications In Civil & Environmental Engineering," Wiley.
- Benjamin, J. R. and C. A. Cornell (1970). Probability, Statistics, and Decision for Civil Engineers. New York, McGraw-Hill.
- Kutner M.H., Nachtsheim C., and Neter J., 2004. Applied linear regression models, McGraw-Hill, 1396 p.

ASSESSMENT	**% of Final Mark**	**Documentation**
Assignments	20%	Open
Final Examination	80%	Closed books and closed notes