



Civil Engineering for Mitigation of Risk from Natural Hazards

Course: Probability and Statistics for Engineering Applications

a.y.: 2020/2021

Lecturers: Prof. Paolo Bazzurro, Prof. Paolo Venini

Date: 08/02/2021 – 05/03/2021

Classroom: online and UNIPV (See time schedule below for more details)

COURSE SCHEDULE

Week	Classroom	Date	Lecture hours	Tutorial hours	Tot h
			From____ To____	From____ To____	
1	online	08-Feb	9:00-12:00		3
	online	09-Feb	9:00-12:00		3
	online	10-Feb	9:00-12:00		3
	online	11-Feb	9:00-12:00	16:00-18:00	5
	online	12-Feb		14:00-16:00	2
2	online	15-Feb	9:00-12:00		3
	online	16-Feb	9:00-12:00		3
	online	17-Feb	9:00-12:00	16:00-18:00	5
	online	18-Feb	9:00-12:00	16:00-18:00	5
	online/UNIPV	19-Feb	14:30-16:30	midterm exam	2
3	online	22-Feb	9:00-12:00	16:00-18:00	5
	online	23-Feb	9:00-12:00		3
	online	24-Feb	9:00-12:00	14:00-17:00	6
	online	25-Feb	10:00-12:00	14:00-17:00	5
	online	26-Feb			
4	online	01-Mar		14:00-16:00	2
	online	02-Mar		9:00-12:00	3
	online	03-Mar			
	online	04-Mar			
	online/UNIPV	05-Mar	9:00-12:00	final exam	3

OBJECTIVES

Most problems in the different fields of Civil Engineering cannot be fully and efficiently addressed without knowledge of probability and statistics. In this course we will make an attempt to cover some basic aspects of probability and statistics that relate to practical matters keeping dice tossing and card games to a bare minimum. Less emphasis will be given to derivations and more to concepts and applications. We will start by discussing why probability and statistics are related but are not the same. Concept and definition of

random variables and different functions of random variables will be covered in this initial part of the course. Afterwards, focus is given to commonly used probability distribution functions in civil engineering. Discussions on statistics and sampling are presented towards the last part of the course. In this part, goodness of fit tests, regression analysis, estimation of distribution parameters from statistics, hypothesis testing and their significance will be discussed. Finally basics of Monte Carlo simulation and an introduction to variance reduction techniques will also be covered. Each topic is discussed with reference to different application problems and their solutions in different fields of civil engineering, such as Structural Engineering, Earthquake Engineering, Transportation Engineering, Water Resources and Environmental Engineering, and Geotechnical Engineering. Basic applications of decision analysis will also be introduced. The course will be taught in English.

DESCRIPTION

Theoretical lectures will be complemented by tutorials (aiming at practical application of the concepts and methods developed during the lectures). The topics to be discussed in the course are reported in the following:

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
Evaluation		
Assignments	25%	Open
Midterm Examination	25%	Closed books and notes
Final Examination	50%	Closed books and notes