



ROSE
**Master of
Science**

Civil Engineering
for Mitigation
of Risk from
Natural Hazards

Risk Assessment and Loss Estimation

Lecturers: P. Bazzurro, D. Vamvatsikos, M. Kohrangi
Date: 21/09/2026 – 21/10/2026
Credits: 6 ECTS (CFU)

Course Description

This course comprises three distinct but well-connected parts. The main focus of the course is on seismic risk but it will also deal with risk assessment for other perils.

This course will start with a very succinct overview of the basics of probability and statistics that are commonly used in the field of hazard and risk assessment. The knowledge of the subject is a pre-requisite of the course. After this preamble, in the first part (weeks 1 and 2) we will move on to describe the basics of risk assessment and loss estimation for assets subject to natural events such as earthquakes and tropical cyclones. In this part we will also review the fundamentals of seismic hazard analysis and we will cover both probabilistic and deterministic approaches. Then we will deal with the theory behind catastrophe risk modeling of portfolios of structures mostly for earthquakes but will discuss tropical cyclones as well. The applications discussed are typical of those found in the insurance/reinsurance industry, capital markets, and sovereign disaster risk financing. Therefore, some fundamentals of insurance/reinsurance will also be provided. Then we will introduce the concepts of seismic risk for single structures and we will compare and contrast them with the approach for portfolio of assets. Time permitting, we will discuss the earthquake risk assessment of lifelines, industrial facilities and of nuclear power plants. These cases have special aspects that are not found in the previous applications discussed during the course.

The second part of the course (week 3) will focus on the application of the portfolio seismic risk assessment theory covered in the first two weeks of the course to real case studies. In this part you will be using models already built and the emphasis will be in learning how to compute and interpret correctly their results.

Finally, the third and last part (week 4) will tackle in detail the state-of-the art approach to assess seismic risk of single buildings for both collapse and loss estimation purposes. The techniques that you will learn here are applicable both to the seismic design of new buildings and to the assessment of the performance of existing ones.

Topics

- Earthquake hazard and risk assessment for portfolios of buildings and for single buildings;
- Hurricane hazard and risk assessment for portfolios of buildings;
- Time permitting, earthquake risk assessment of lifelines, industrial facilities and of nuclear power plants.

Learning Outcomes

Students will learn the basics of risk assessment of single structures and portfolios of structures as they are carried out in the private sector.

Suggested reading material / Reference textbooks (if applicable)

- Ang A.H. and Tang W.H. (2007). Probability Concepts In Engineering: Emphasis On Applications In Civil & Environmental Engineering, Wiley.
- Benjamin J.R. and Cornell C.A. (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 pp.
- Mitchell-Wallace K., Jones M. (editor), Hillier J. (editor), Foote M. (editor)(2017) Natural Catastrophe, Risk modeling and management - A practitioner's Guide, Wiley Blackwell.
- Gero M. (editor)(2018) Risk Modeling for Hazards and Disasters, Elsevier, (ISBN: 978-0-12-804071-3).
- Gordon Woo: The Mathematics of Natural Catastrophes' (ISBN-13: 978-1860941825) and Calculating Catastrophe (ISBN-13: 978-1848167391) published by Imperial College Press.
- Grossi P. and Kenreuther H. Editors (2005) Catastrophe Modeling: A New Approach to Managing Risk, Huebner International Series on Risk, Insurance and Economic Security (ISBN-13: 978- 0387241050).

Assessment Methods

The course does include three exams:

- Single Building Risk Assignment Report.....Friday, October 16, 2:00-4:00 pm
- Final exam – Risk Assessment General Material.....Monday, October 20, 9:00-11:00 am
- Final Portfolio Risk Study Presentation.....Tuesday, October 21, 9:00-12:00 pm

With the following grading structure:

Seismic Hazard Assignment	5%
Final Written Exam.....	50%
Single Building Risk and Loss Estimation Assessment	25%
Portfolio Earthquake Loss Assessment.....	20%

Schedule

 **Classrooms at Palazzo del Broletto** – IUSS Pavia, Piazza della Vittoria 15

WEEK 1								
Paolo Bazzurro		21-Sep Monday	22-Sep Tuesday	23-Sep Wednesday	24-Sep Thursday	25-Sep Friday		
	Lectures	09:00-12:00	09:00-12:00	09:00-12:00		09:00-12:00	Tot Lectures	12
	Tutorials				10:00-12:00		Tot Tutorials	4
	Seminars			14:00-16:00	14:00-16:00	14:30-16:30	Tot Seminar	4
							Tot week 1	20
WEEK 2								
Paolo Bazzurro		28-Sep Monday	29-Sep Tuesday	30-Sep Wednesday	01-Oct Thursday	02-Oct Friday		
	Lectures	09:00-12:00	09:00-12:00	09:00-13:00	09:00-12:00		Tot Lectures	13
	Tutorials						Tot Tutorials	0
	Seminars	14:00-16:00	14:00-16:00				Tot Seminar	4
							Tot week 2	17
WEEK 3								
Mohsen Kohrangi		05-Oct Monday	06-Oct Tuesday	07-Oct Wednesday	08-Oct Thursday	09-Oct Friday		
	Lectures	10:00-12:00	10:00-12:00	10:00-12:00			Tot Lectures	8
	Tutorials	13:30-15:30	13:30-15:30	13:30-15:30			Tot Tutorials	4
							Tot week 3	12
WEEK 4								
Dimitrios Vamvatsikos		12-Oct Monday	13-Oct Tuesday	14-Oct Wednesday	15-Oct Thursday	16-Oct Friday		
	Lectures	10:30-12:30	10:30-12:30	10:30-12:30	10:30-12:30	10:30-12:30	Tot Lectures	18
	Tutorials	14:00-16:00	14:00-16:00	14:00-16:00	14:00-16:00	14:00-16:00	Tot Tutorials	8
	Exam	16:00-18:00	16:00-18:00	16:00-18:00	16:00-18:00			
							Single bldg exam 14:00-16:00	
							Tot Exams	2
							Tot week 4	26
WEEK 5								
		19-Oct Monday	20-Oct Tuesday	21-Oct Wednesday	22-Oct Thursday	23-Oct Friday		
	Lectures						Tot Lectures	0
	Tutorials						Tot Tutorials	0
	Exams	Final exam risk assessment - general material 9:00-11:00	Bldg portfolio exam 9:00-12:00					
							Tot Exams	5
							Tot Lectures	51
							Tot Tutorials	16
							Tot Exam	7
							Grand Tot	74