Course Title: **Performance-Based Earthquake Engineering**
Lecturer: Gerard J. O'Reilly
Dates: 23rd January – 3rd February 2023
Hours: 24 lectures + 10 tutorials
Location: Palazzo del Broletto, Aula 1-17
Teaching Assistant: Al Mouayed Bellah Nafeh

Description

This course covers topics related to performance-based earthquake engineering (PBEE) of new and existing buildings. A quick background on the development of PBEE is first provided, outlining its early beginnings, followed by the notable developments in the past 25 years that have led to the current and avant-garde approaches available in the literature. This relates to the design and assessment of buildings, particularly those commonly found in Italy and Southern Europe. The course focuses on the ingredients necessary for quantifying uncertainties, calculating risk, and estimating economic losses. Advanced topics such as risk-targeted seismic design methods are presented in addition to both simplified and extensive risk assessment methods available to practitioners. Other issues relating to ground motion and intensity measure selection to characterise seismic response are also covered. The course aims to provide students who are already familiar with current building codes and other standard seismic analysis methods with a better understanding of these advanced topics and state-of-the-art methods available within modern PBEE.

Grading

Course project   40%
Final exam   60%

Schedule

	Date	Time	Topic
Week 1	Monday 23/01/2023	09:00 – 12:00	**1. Course Overview** **2. Analysis Methods - Part I** • Non-linear static analysis • Non-linear dynamic analysis • MDOF vs SDOF models • Incremental dynamic analysis (IDA)
		15:00 – 17:00	Tutorial: Part 1 - Identification of case study building and site hazard
	Tuesday 24/01/2023	09:00 – 11:00	Tutorial: Part 2 - Static pushover and modal analysis
		15:00 – 18:00	**3. Seismic Risk - Part I** • Seismic hazard, logic trees and disaggregation • Fragility functions (FFs) • Derivation of FFs from IDA • Calculation of risk
	Wednesday 25/01/2023	09:00 – 12:00	**4. Analysis Methods – Part II** • Cloud analysis (CA) • Multiple stripe analysis (MSA) • Derivation of FFs from CA and MSA • Simplified analysis methods
		15:00 – 17:00	Tutorial: Part 3 - Incremental dynamic analysis
	Thursday 26/01/2023	09:00 – 12:00	**5. Intensity Measures (IMs)** • Traditional definitions and novel developments • IM choice – efficiency, sufficiency, practicality • Potential bias in structural response • Ground motion record scaling
		15:00 – 18:00	**6. Ground Motion Record Selection** • Code-based selection • Hazard-consistency • Conditional spectrum • Generalised conditional intensity measure (GCIM) • Scenario-based analysis and spatial correlation **7. Seismic Risk - Part II** • Demand-intensity models • Sources of uncertainty • Demand-hazard curves
	Friday 27/01/2023	09:00 – 11:00	Tutorial: Part 4 - Identification of ground motion records
		15:00 – 17:00	Tutorial: Part 5 - Multiple stripe analysis
Week 2	Monday 30/01/2023	09:00 – 12:00	**8. Loss and Risk Assessment** • Component-based loss assessment • Storey loss function-based assessment • Simplified risk assessment
		15:00 – 17:00	Tutorial: Part 6 - Economic loss and collapse risk
	Tuesday 31/01/2023	09:00 – 12:00	**9. Risk (and Loss)-Targeted Design** • Risk-targeted spectra • Risk-targeted behaviour factors • Yield-frequency spectra • Integrated performance-based seismic design
		15:00 – 17:00	Tutorial: Part 7 - Risk-targeted design
	Wednesday 01/01/2023	09:00 – 12:00	**10. Typology-Specific Issues** • Infilled frame structures • Unreinforced masonry structures (Prof. F. Graziotti – UniPV) **11. Future Directions** • Downtime • Indirect losses
	Thursday 02/02/2023	14:00 – 17:00	**Project presentations**
	Friday 03/02/2023	09:00 – 12:00	**Final Exam**