ROSE School | Earthquake Engineering

Fundamentals of Probability Theory

Lecturer: **I. Iervolino**
Date: 16/02/2026 – 27/02/2026
Credits: 3 ECTS (CFU)

Course Description

The course aims at providing the basics of probability theory and calculus for the quantitative characterization of uncertainty and its mathematical treatment in engineering problems. The course will start with the concept of random experiment, event's algebra, the Kolmogorov's axiomatic approach to probability, the following calculus' rules and methods, including simulation. It will explore the characterization of random variables, including most common models, and will also give some entry information about collections of random variables or stochastic processes. The course will also discuss interpretations of probability, key differences in frequentist and Bayesian approaches, and common classification of uncertainties in engineering. It will address the basic, time-invariant, stress-strength problem. The course will include in-class exercises on all topics addressed, homeworks, and a final exam.

Topics

- Random experiments;
- Events and Venn's diagrams;
- Events' algebra;
- Probability definitions and interpretations;
- Axioms of probability and calculus' rules;
- Discrete, continuous and mixed random variables;
- Marginal probability distributions: parametric and non-parametric models;
- Joint distributions of random variables
- Simulation methods for probability calculus;
- Elements of inferential statistics;
- Common classification of uncertainties in engineering problems;
- Stress-strength model and failure probability for engineering systems;
- Elements of point stochastic processes.

Learning Outcomes

Students taking the course and passing the exam are expected to gather the mindset for uncertainty characterization in engineering problems and to be able to set up a strategy to compute the sought probabilities for the problem at hand. More specifically, the course intends to give students the theoretical grounds for the following seismic hazard and risk assessment classes.