**Insegnamento: STRUCTURAL RELIABILITY**

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| **CFU: 9** | **SSD: ICAR/09** |
| **Ore di lezione: 54** | **Ore di esercitazione: 27** |

**LAUREA MAGISTRALE IN INGEGNERIA STRUTTURALE E GEOTECNICA - Anno di corso:**

**Obiettivi formativi:**

The course introduces alternative methods for the assessment of structural reliability. It begins by providing a brief overview of elementary concepts in probability, the history of the field of structural reliability and its evolution, and the general framework for structural reliability assessment. Next, the students are going to get to know classical methods for component reliability assessment such as FOSM, FORM, and SORM. Furthermore, classical methods for systemic reliability assessment are discussed. Simulation-based reliability methods are introduced next as an alternative to classical methods. The focus is on the use of standard Monte Carlo Simulation methods; however, notions of a few advanced and more efficient simulation routines are provided. Seismic performance-based structural safety assessment is a special focus of the course, and the students are going to learn how to evaluate structural risk and reliability due to seismic actions. In particular, they are going to evaluate the risk integral through introduction of intermediate variables such as seismic intensity measure (IM), engineering demand parameters (EDP), and damage measure (DM). Finally, Demand and Capacity Factor Design format for seismic safety-checking (DCFD) is introduced as an analytic closed-form solution to the risk integral.

**Contenuti:**

***Elementary Concepts in Structural Reliability and Safety***

Brief overview of elementary probability and statistics, A brief history of the field of structural reliability and its evolution, General Framework for structural reliability assessment, Limit States, Failure Probability, Risk, Acceptable risk levels, Characterization of uncertainties

***Classical Reliability Assessment Methods***

Safety Margin and Safety Factor formulations for component reliability assessment, The Mean-Value First-Order Second-Moment method for reliability assessment (MVFOSM), The First-Order Second-Moment reliability (FOSM), Importance measures, Full distribution reliability methods, transformation into the standard Normal space, Nataf Distribution, First-Order Reliability Method (FORM), Second-Order Reliability Method (SORM), Systemic Reliability Assessment (systems in series and parallel, cut-sets, path-sets).

***Simulation-based Reliability Assessment***

Monte Carlo Method for structural reliability assessment, Importance Sampling, Markov-Chain Monte Carlo Simulation, Subset Simulation, The estimation of errors.

***Performance-based seismic safety assessment***

Introduction of seismic intensity measure (IM), engineering demand parameters (EDP), and damage measure (DM) as intermediate variables, Various risk metrics/decision variables (DV) (e.g., expected economic loss), The risk integral, Seismic fragility, Various types of fragility (EDP versus IM, DM versus EDP, and DM versus IM), Application of alternative non-linear structural analysis procedures (e.g., static pushover analysis, incremental dynamic analysis, multiple-stripe analysis, CLOUD analysis, etc.) in fragility assessment, Demand and Capacity Factor Design format for seismic safety-checking (DCFD).

***Specific exercises:*** Application of alternative reliability assessment methods for safety-checking of a simple moment-resisting frame structure

***Software***: Brief applications in Matlab and Opensees

**Docente: Prof. Ing. FATEMEH JALAYER**

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| **Codice:** | **Semestre:** |

**Prerequisiti / Propedeuticità:** Nessuna

**Metodo didattico:** Lectures, Exercises

**Materiale didattico** :

- R. E. Melchers. Structural reliability analysis and prediction, 2nd Ed., 2002, John Wiley.

- O. Ditlevsen, H. O. Madsen. Structural Reliability Methods, Internet Edition, 2007, John Wiley & Sons
- J. Benjamin, C.A. Cornell, Probability, Statistics, and Decision for Civil Engineers, Dover Books on Engineering, 2014
- Au, S.K. and Wang, Y., 2014. Engineering risk assessment with subset simulation. John Wiley & Sons.
- Jalayer F, Cornell CA. A technical framework for probability-based demand and capacity factor design (DCFD) seismic formats. Pacific Earthquake Engineering Center (PEER) 2003/08.
- FEMA-SAC Joint Venture. Recommended seismic design criteria for new steel moment-frame buildings. Federal Emergency Management Agency, 2000. FEMA-547, Federal Emergency Management Agency, 2006.
- FEMA 445-ATC-58: Next-Generation Performance-based Earthquake Engineering Design Criteria for Buildings: Program Plan for New and Existing Buildings, 2006.


**Modalità di esame:** Discussion of the project and an oral exam on course contents