Department of Civil Engineering

Course Name:

Reliability, Risk and Resilience

Course Number: 20-010	**Credit:** 3
Program: Undergraduate	**Course Type:** Technical elective
Prerequisite: -	**Corequisite:** -

Course Description (Objectives):
The primary objective of this course is twofold: First, to learn the skills of dealing with uncertainties in engineering and second, to learn how to use these skills in reliability, risk, and resilience analysis of civil infrastructure. The course focuses on the topics of uncertainty quantification, reliability analysis, risk analysis, resilience analysis, and decision analysis. Students completing this course will be able to understand the vast and growing body of the literature on reliability, risk, and resilience. They will also be able to quantify uncertainties in any civil engineering discipline, and to carry out reliability, risk, and resilience analyses both manually and using computer programs while understanding the theory behind.

Course Content (outline):

- **Introduction and background**
  - Motivation
  - Uncertainties
  - Set theory
  - Probability theory
- **Decision analysis**
  - Decision trees
  - Expected cost theory
  - Introduction to reliability-based design optimization
- **Probabilistic models**
  - Discrete distribution models
  - Continuous distribution models

  - Bayesian inference
  - Multivariate distribution models
- **Reliability**
  - Analysis of functions
  - Probability transformations
  - Basic reliability problem
  - Mean-value first-order second-moment method
  - Sampling methods
- **Risk**
  - Disaster
    - Hazard
    - Infrastructure
    - Consequence
    - Earthquake
  - ATC-13 risk analysis framework
  - FEMA-NIBS risk analysis framework
  - Reliability-based risk analysis framework
- **Resilience**
  - Definition of resilience
  - Design philosophies
    - Allowable stress design
    - Load and resistance factor design
    - Performance-based design
    - Resilience-based design
  - Properties of resilience
    - Robustness
    - Rapidity
    - Resourcefulness
    - Redundancy
  - Robustness quantification via risk models
  - Recovery analysis via agent-based models
  - Resourcefulness via Bayesian network

References:

- Haldar and Mahadevan (1999), Probability, Reliability, and Statistical Methods in Engineering Design, Wiley
- Der Kiureghian (2005), First- and Second-order Reliability Methods. Chapter 14 in Engineering Design Reliability Handbook, Edited by Nikolaidis, Ghiocel, and Singhal, CRC Press
- ATC (1985). Earthquake Damage Evaluation for California. ATC-13, Applied Technology Council, Redwood City, CA
- FEMA-NIBS (2012). Earthquake Loss Estimation

Methodology, HAZUS Technical Manual. Federal Emergency Management Agency and National Institute of Building Sciences, Washington, DC

- Cimellaro (2016), Urban Resilience for Emergency Response and Recovery. Springer International Publishing, Switzerland