

Structural Reliability and Probabilistic Modeling (20-130)

Number of credits: 3

Objectives

The primary objective of this course is to learn how to deal with uncertainties in engineering. The course focuses on three main topics: 1) Probabilistic modeling with the objective of learning to establish engineering models considering prevailing uncertainties; 2) Reliability analysis with the objective of learning to compute event probabilities; 3) Decision analysis with the objective of learning how to make rational, risk-based decisions, especially in design. Students completing this course will be able to understand the vast and growing body of the literature on probabilistic modeling, structural reliability, and risk analysis. They will also be able to carry out probabilistic analyses with computer programs while understanding the theory behind. Although the examples in this course emphasize structural and earthquake engineering applications, the methods are broadly applicable to probabilistic analyses in many disciplines.

Content

- Introduction and background
 - Motivation
 - Uncertainty
 - Probability
 - Set theory
 - Probability theory
- Decision analysis
 - Decision tree
 - Expected cost theory
 - Expected utility theory
 - Reliability-based design optimization
 - Terminal analysis
 - Pre-posterior analysis
- Probabilistic modeling
 - Discrete distribution models
 - Continuous distribution models
 - Bayesian inference
 - Multivariate distribution models
 - Extreme-value models
 - Linear regression models
 - Occurrence models
 - Stochastic process models
 - Random field models
- Reliability analysis
 - Analysis of functions
 - Probability transformation
 - Basic reliability problem

- Mean-value first-order second-moment method
- Invariance problem
- First-order reliability method
- Importance and sensitivity measures
- Second-order reliability method
- Sampling methods
- Response surfaces and neural networks
- Finite element reliability analysis
- Risk analysis using reliability methods
- System reliability analysis
- Load combination
- Code calibration

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
- Melchers (1999), Structural Reliability: Analysis and Prediction, Prentice Hall
- Ditlevsen and Madsen (2007), Structural Reliability Methods, John Wiley & Sons, Chichester, UK
- Ang and Tang (2007), Probability Concepts in Engineering: Emphasis on Applications in Civil and Environmental Engineering, Wiley
- Madsen, Krenk, and Lind (1986), Methods of Structural Safety, Prentice-Hall
- Benjamin & Cornell (1970), Probability, Statistics and Decision for Civil Engineers, McGraw-Hill
- Ang and Tang (1984), Probability Concepts in Engineering Planning and Design, Volume II, Decision, Risk and Reliability, Wiley