CIV E 779: Structural Reliability

Winter 2026

Department of Civil and Environmental Engineering
University of Alberta, Edmonton, Canada

Instructor:	Dr. Yong Li	**Time:**	To be Scheduled with Students
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General: This course "Structural Reliability" will focus on probabilistic methods for practical application of reliability and risk. Concepts and examples will be given mainly in the context of structural engineering, but they are equally applicable to other fields.

Objectives: This course aims to cover both the theoretical, computational, and practical aspects of modern structural reliability and risk analysis. Its goal is to help the students understand the underlying concepts and theories in probability-based performance assessment and probabilistic codified design as well as some advanced probabilistic methods in engineering. The main type of problem to be solved in this course is to calculate the probability of violating a limit-state or performance level for a structural system associated with various source of uncertainties. Thus, this course is primarily designed for graduate students, who are interested in:

- seeking for a deeper understanding of design standards or codes with a probabilistic basis;
- conducting research on solving various engineering problems in the face of uncertainty;
- seeking a career path in the field of the risk engineering to deal with various sources of uncertainty/randomness.

Course Goal: The course tends to cover:

- The basic concepts in probability theory.
- The fundamental concepts and theory in structural reliability.
- Structural component and system reliability analysis.
- Sampling methods for reliability analysis.
- Probabilistic codified design
- Implementation of structural reliability analysis program (e.g, Python).
- Basic use of a Reliability Software (e.g., *OpenSees*).
- Time-invariant reliability methods

Prerequisites:

- Undergraduate course on probability and statistics (e.g., STAT235 Introductory Statistics for Engineering or equivalent). A quick review will be provided in the beginning of the class.
- Linear algebra

- Some computer programming (e.g., MATLAB, Python, MATHEMATICA)

Office Hours:

- By appointment.

Textbook: No textbook is required. Lecture notes will be provided.

Main References: This is a restricted list of various useful books that will be touched during the course. You need to consult them occasionally. Other references (e.g.,journal/conference papers) will be provided along with the lectures.

- Ang, A. H-S., and Tang, W.H., *Probability Concepts in Engineering - Emphasis on Applications to Civil and Environmental Engineering*, Wiley, New York, 2007.
- Madsen, H.O., Krenk, S., and Lind, N.C., *Methods of Structural Safety*, Prentice-Hall, Englewood Cliffs, New Jersey, 1986.
- Ang, A. H-S., and Tang, W.H., *Probability Concepts in Engineering Planning and Design, Vol II - Decision, Risk and Reliability*, John Wiley and Sons, New York, 1984.
- Benjamin, J.R., and Cornell, A.C., *Probability, Statistics and Decision for Civil Engineers*, McGraw-HIll, 1981.
- Ditlevsen, R., and Madsen, H.O., *Structural Reliability Methods*, John Wiley, 2005.
- Melchers, R.E., *Structural Reliability Analysis and Prediction*, John Wiley and Sons, 2nd edition, 1999.
- Der Kiureghian, A., *Structural and System Reliability*, Cambridge University Press, 1st edition, 2022.

Grading Policy: Homework assignments (30%), Midterm exam (30%), and Final project (40%).

NOTE: The Midterm will be for the the theoretical basis of probability and reliability; The final project can be literature review of reliability methods or applications to a specific type of engineering system, case study of reliability methods/algorithms or application of reliability methods to the problem of your interest, or other topics related to probabilistic engineering analysis.

Important Dates:

Homework	(Approx. a total of 5)
Midterm	TBD
Final Project	TBD

Class Policy:

- Discussion and collaboration is encouraged in this class, but everyone **HAS TO** submit his own version of homework or project report with acknowledgment to the collaborators.

Academic Honesty: Lack of knowledge of the academic honesty policy is not a reasonable explanation for a violation. The details of the policy for Code of Student behavior can be found on line.

General Comments: This course is will cover advanced topics on structural reliability and risk analysis. Students will be required to set up or select a problem related to their research, analyze the uncertainty associated, and apply the reliability methods to the selected problem.