

TEXAS TECH UNIVERSITY
Department of Civil, Environmental & Construction Engineering

CE 5341: Structural Reliability
DD/DD HH:MM HH:MM
Semester YYYY – instructor

Instructor

Ting Lin, PhD

Assistant Professor

Department of Civil, Environmental & Construction Engineering

Office Hours: Open lobby + one-on-one (Time TBD via class votes)

Phone: (806) 834-5327

E-Mail: instructor.name@ttu.edu

Website: <https://www.depts.ttu.edu/ceweb/faculty/instructor.name>

Welcome to Structural Reliability: Reliability is present everywhere, across scales and disciplines. From building collapse in Chile Earthquake to Space Shuttle Challenger disaster, you will soon appreciate the concept of probability of failure and its mathematical representation. This new TTU class in Structures provides an opportunity for MS/PhD students in the Department of Civil, Environmental, and Construction Engineering to gain understanding of structural reliability and transfer concepts to useful applications:

- Open to students with background in basic probability and statistics
- Introducing concepts and applications of reliability
- Covering fundamentals of reliability theory and its associated computational methods
- Incorporating student-centered learning via research and applications of interest

Learning Objectives

This course is designed to introduce graduate students to concepts and applications of structural reliability. Upon completion of this course, students will be able to:

- Formulate a reliability question to solve engineering problems of interest
- Compute first- and second-order estimates of failure probabilities of engineered systems
- Compute sensitivities of failure probabilities to assumed parameter values
- Measure the relative importance of the random variables associated with a system
- Identify the relative advantages and disadvantages of various analytical reliability methods as well as Monte Carlo simulation
- Update reliability estimates based on new observational data
- Compute system reliability for series and parallel systems

Readings, Materials, and Resources

There is no required textbook for this course. Related readings, materials and resources will be posted on Blackboard/Microsoft Teams. The following textbooks could be used as optional references:

Ditlevsen, O. and Madsen, H. O. (2007). Structural reliability methods, Internet Edition 2.3.7, John Wiley & Sons, Chichester, UK. <http://od-website.dk/books/OD-HOM-StrucRelMeth-Ed2.3.7.pdf>

- Woo, G. (2011). Calculating Catastrophe, Imperial College Press, London, UK. ProQuest Ebook Central, <https://ebookcentral.proquest.com/lib/ttu/detail.action?docID=840546>. (TTU: unlimited access)
- Melchers, R. E. (1999). Structural reliability analysis and prediction, 2nd Ed., John Wiley & Sons, Chichester, UK.
- Benjamin, J. R. and Cornell, C. A. (1970). Probability, Statistics, and Decision for Civil Engineers, McGraw-Hill Book Company, New York, USA.

Course Topics

- General component reliability
- First-order second-moment (FOSM) methods
- First order reliability method (FORM)
- Importance measures and parameter uncertainty
- Second-order reliability method (SORM)
- Monte Carlo simulation and importance sampling
- Reliability updating
- System reliability

Prerequisites

Required: This course will assume

- Basic knowledge of **probability and statistics**, e.g., descriptions of random variables, probability distributions, functions of random variables, estimation of model parameters, model selection and verification, covered by CE 5331-009 Probabilistic Methods for Civil Engineers (e.g., IE 3341 Engineering Statistics, ISQS 5346 Statistics for Data Science, MATH 4342/4343 Mathematical Statistics, POLS 5382 Data Analysis, STAT 5302/5303 Applied Statistics, or STAT 5384/5385 Statistics for Engineers and Scientists).
- **Linear algebra**, e.g., systems of equations, matrix operations, transformations.
- **Calculus and differential equations**, e.g., differentiation, integration, ordinary and partial differential equations.

Preferred: Basic programming using Matlab, Python, C, or equivalent programs.

Assessment

Students will be evaluated on their ability to explain the course concepts and perform calculations using the techniques presented. Grades will be computed using the following weighting scheme:

- Class participation/quizzes/innovation: **20%**
- Homework assignments: **30%**
- Midterm: **20%** (tentative)
- Final project: **30%**

Students are expected to actively participate in class discussions and contribute to the community of scholars, with independent and collaborative research elements, promoting a culture of innovation. Homework assignments will typically consist of questions that develop further understanding of the materials presented in class. Exam format will be similar to that of the homework assignments. The final project will provide students an opportunity to apply the concepts learned in this course to their applications of interest.

STATEMENTS

ADA (as per OP 34.22)

Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor's office hours. Please note instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, you may contact the Student Disability Services office at 335 West Hall or 806-742-2405.

Academic Integrity (as per OP 34.12)

Academic integrity is taking responsibility for one's own class and/or course work, being individually accountable, and demonstrating intellectual honesty and ethical behavior. Academic integrity is a personal choice to abide by the standards of intellectual honesty and responsibility. Because education is a shared effort to achieve learning through the exchange of ideas, students, faculty, and staff have the collective responsibility to build mutual trust and respect. Ethical behavior and independent thought are essential for the highest level of academic achievement, which then must be measured. Academic achievement includes scholarship, teaching, and learning, all of which are shared endeavors. Grades are a device used to quantify the successful accumulation of knowledge through learning. Adhering to the standards of academic integrity ensures grades are earned honestly. Academic integrity is the foundation upon which students, faculty, and staff build their educational and professional careers. [Texas Tech University ("university") quality enhancement plan, academic integrity task force, 2010]

Religious Holy Day:

"Religious holy day" means a holy day observed by a religion whose places of worship are exempt from property taxation under Texas tax code §11.20. A student who intends to observe a religious holy day should make that intention known in writing to the instructor prior to the absence. A student who is absent from classes for the observance of a religious holy day shall be allowed to take an examination or complete an assignment scheduled for that day within a reasonable time after the absence. A student who is excused under section 2 may not be penalized for the absence; however, the instructor may respond appropriately if the student fails to complete the assignment satisfactorily.

Discrimination, Harassment, and Sexual Violence Statement:

Texas Tech University is committed to providing and strengthening an educational, working, and living environment where students, faculty, staff, and visitors are free from gender and/or sex discrimination of any kind. Sexual assault, discrimination, harassment, and other Title IX violations are not tolerated by the university. Report any incidents to the office for student rights & resolution, (806)-742-safe (7233) or file a report online at titleix.ttu.edu/students. Faculty and staff members at TTU are committed to connecting you to resources on campus. Some of these available resources are: TTU student counseling center, 806-742-3674, <https://www.depts.ttu.edu/scc/> (provides confidential support on campus.) TTU 24-hour crisis helpline, 806-742-5555, (assists students who are experiencing a mental health or interpersonal violence crisis. If you call the helpline, you will speak with a mental health counselor.) Voice of

hope Lubbock rape crisis center, 806-763-7273, voiceofhopelubbock.org (24-hour hotline that provides support for survivors of sexual violence.) The risk, intervention, safety and education (RISE) office, 806-742-2110, <https://www.depts.ttu.edu/rise/> (provides a range of resources and support options focused on prevention education and student wellness.) Texas Tech police department, 806-742-3931, <http://www.depts.ttu.edu/ttpd/> (to report criminal activity that occurs on or near Texas Tech campus.)

Civility in the Classroom:

Texas Tech University is a community of faculty, students, and staff that enjoys an expectation of cooperation, professionalism, and civility during the conduct of all forms of university business, including the conduct of student–student and student–faculty interactions in and out of the classroom. Further, the classroom is a setting in which an exchange of ideas and creative thinking should be encouraged and where intellectual growth and development are fostered. Students who disrupt this classroom mission by rude, sarcastic, threatening, abusive or obscene language and/or behavior will be subject to appropriate sanctions according to university policy. Likewise, faculty members are expected to maintain the highest standards of professionalism in all interactions with all constituents of the university (www.depts.ttu.edu/ethics/matadorchallenge/ethicalprinciples.php).

LGBTQIA Support:

Office of LGBTQIA, student union building room 201, www.lgbtqia.ttu.edu, 806.742.5433 within the center for campus life, the office serves the Texas Tech community through facilitation and leadership of programming and advocacy efforts. This work is aimed at strengthening the lesbian, gay, bisexual, transgender, queer, intersex, and asexual (LGBTQIA) community and sustaining an inclusive campus that welcomes people of all sexual orientations, gender identities, and gender expressions.

Student Grade Appeals (as per OP 34.03)

The student will have the right to appeal the receipt of a failing grade in a course through the established grade appeal procedure. The student may not appeal a failing grade given for a class assignment or exam.

Military Personnel Ordered to Active Duty (as per OP 34.13) Please see instructor.

Operational Procedures (OP)

The University's Operational Procedures can be viewed/downloaded from <http://www.depts.ttu.edu/opmanual/>

Revision to Syllabus:

Topics and/or dates may be changed during the semester at the instructor's discretion because of scheduling issues, developments in the discipline, or other contingencies.