STA255H1S Summer 2025: Statistical Theory

Department of Statistical Sciences, University of Toronto

Session	**Time & Location**	**Instructor:** Siqi Zheng, MSc.
LEC5101	Tue. 18:00 - 21:00, NL 006	**Course email:** sta255@course.utoronto.ca
	Thu. 18:00 - 21:00, NL 006	**Office hours**: Thu. 1-3pm/by appointment
TUT5101	Tue. 17:00 - 18:00,	TA: Hamda Altaf, hamda.altaf@mail.utoronto.ca
	Thu. 17:00 - 18:00,	TA: Nnenna Asidianya,
TUT5102	Tue. 17:00 - 18:00,	nnenna.asidianya@mail.utoronto.ca
	Thu. 17:00 - 18:00,	TA: Zi Cheng Liu, stephenzicheng.liu@mail.utoronto.ca

Course overview

Course Description: This course provides a modern introduction to the mathematical foundations of probability and statistical inference, with a strong emphasis on intuitive understanding, mathematical formulation, and real-world applications. Key topics include discrete and continuous probability distributions, expectation and variance, sampling distributions, estimation, hypothesis testing, and the basics of statistical modeling. Active learning techniques such as simulation-based exploration, coding exercises in R, and real-world problem-solving are integrated throughout the course to strengthen students' statistical reasoning and communication skills. (Note: STA255H1 does not count as a distribution requirement course.)

Learning Outcomes: By the end of the course, students will be able to:

1. Explain key probability and statistical concepts and apply appropriate models to real-world data.
2. Compute and interpret statistical summaries, distributions, and estimators using both analytical and simulation-based approaches.
3. Critically evaluate assumptions underlying statistical models through proofs and simulation.
4. Reflect on the strengths, limitations, and appropriate uses of statistical models across varied contexts.

Pre-requisites: STA220H1/ STA221H1/ STA288H1/ ECO220Y1 (note: ECO220Y1 may be taken as a co-requisite)/ STAB22H3/ STA220H5/ ECO220Y5; MAT133Y1 (70%)/ (MAT135H1, MAT136H1)/ MAT137Y1/ MAT157Y1/ (MATA32H3 (70%), MATA33H3 (70%))/ (MATA29H3 (70%), MATA35H3 (70%))/ (MATA30H3, MATA36H3)/ (MATA31H3, MATA37H3)/ MAT133Y5 (70%)/ (MAT132H5 (70%), MAT134H5 (70%))/ (MAT135H5,MAT136H5)/ MAT137Y5/ MAT157Y5

Exclusions: ECO227Y1/ STA237H1/ STA238H1/ STA257H1/ STA261H1/ STA247H1/ STA248H1/ STAB52H3/ STAB57H3/ STA256H5/ STA260H5

Course materials

Course Content: We have a Quercus course page for this course. All lecture slides, assignments and any other materials will be posted on this Quercus course page. In addition, any important announcements will also be posted in Quercus. Please make sure to check it regularly.

Textbook: Probability and statistics: The Science of Uncertainty., Evans, M. J., & Rosenthal, J. S. (2010).

Statistical Software: We will use the R Statistical Software for performing statistical analyses in this course. R is a free software that can either be downloaded onto your personal computer or used in a cloud environment. We encourage all students to use RStudio through the JupyterHub for University of Toronto. This will allow you to login with your official UofT credentials and use RStudio without the need for a local installation and can be run on any device that has access to an internet connection.

Course components

Lectures: In-person lectures occur on Tuesday and Thursday (see ACORN for rooms). When possible, you are encouraged to bring pens and draft paper, or writable electronic device for hands-on practice.

Tutorials: There will be weekly one-hour tutorial sessions throughout the term. To deepen your understanding of the course concepts, the teaching assistants (TAs) will provide tutorials to work thorough problem sets. You are strongly encouraged to attend your tutorials and ask TA questions, as the tutorials are designed to help you with the quizzes and exams.

Office hours: The instructor's office hour is on Thu. 1-3 pm after class or by appointment. In addition, TAs will hold online office hours. Detailed schedule will be posted on Quercus once finalized.

Piazza discussion: We will use the Piazza as an online discussion forum. All questions about course material should be posted here or asked during instructor's or TAs' office hours. The instructor and TAs will monitor the board and will help answer questions but students are encouraged to answer posts and help their fellow classmates.

Grading scheme

Each student's final grade will be computed according to the below grading scheme. No special rounding rules or individual grade adjustments (e.g. to meet GPA cut-offs, minimal requirements for programs, etc.) will be used to calculate course grades. No special reweighting of assessments or extra work will be accepted to account for perceived poor performance, nor to account for any assessment(s) that have been missed without accommodation. There are no exceptions to these policies.

Assessment	**Date Due/ Occurring**	**Weight**
Surveys	2% for each survey	4%
Activity: Simulation Challenges & Quizzes via Quercus	Quizzes will be post weekly on Tue. until 11:59pm on Sun.	16%
Midterm (during scheduled class)	Jul. 24, Thu., 18:20 - 20:00 EX 100	30%
Final exam (during final exam period)	Scheduled by the FAS	50%

Table 1: Grading scheme.

Remark 1: If your final exam grade is better than your midterm, the weighting will be 70% final plus 10% midterm.
Remark 2: The activity mark will be calculated based on the student's best 7 out of 8.
Remark 3: The last day to drop the course without penalty is July 29, 2025.

Evaluation breakdown

Student Feedback Surveys: To help improve the learning experience and gather feedback on teaching and course materials, two surveys will be administered during the term:

Survey	Posted Date	Due Date
Begin Survey	Thursday, July 3	Thursday, July 10, 11:59pm
Midterm Survey	Thursday, July 24	Thursday, July 31, 11:59pm

Table 2: Survey posting and due dates.

These surveys are designed to collect your input on the teaching approach, course content, and other related aspects of the course. Your responses will help shape the remainder of the course to better support your learning. You will be given **class time** to complete each survey. However, if you prefer to complete it on your own time, the survey window will remain open until next Thursday. Your feedback is greatly appreciated and plays an important role in improving the course.

Quizzes via Quercus: **Students will have 4 quizzes via Quercus due by 11:59pm on the following Sunday (Jul. 13, 20; Aug. 3, 10 respectively)**. They will cover that week's materials. Once you start the quiz, you will have exactly **60 minutes** to complete and submit your answers. There are no extensions on the availability periods under any circumstances. The quizzes are open book but must be completed independently (no collaboration permitted – and absolutely no sharing and/or posting of questions and/or answers is permitted).

Simulation Challenges: Throughout the course, students will be assigned a series of Simulation Challenges, designed to deepen their conceptual understanding through hands-on computational exercises. These challenges will be introduced during class and are due by **11:59pm on the next Tuesday night (on Jul. 15, 22; Aug. 5, 12 respectively)**, with submissions to be made via **Quercus**. The exercises focus on key theoretical topics such as the transformation of variables, the convergence properties of the Central Limit Theorem (CLT) and the Law of Large Numbers (LLN), and the **relationships between random variables**. These challenges are intended to complement the lecture material by encouraging students to explore statistical theory in an applied and visual context.

Term Test: The term test will be conducted in person during the scheduled class time **at EX 100**, and it will be 100 minutes long. The test will cover materials taught before Jul. 24, 2025.

Final Exam: The details about the final exam will be provided during the last week lectures. the final exam will be 3 hours in duration and will be scheduled by the Faculty of Arts and Science during the final assessment period.

Late and missed assessment policy

Missed activity: There will be no accommodations made for late or missing the online quizzes or simulation challenges.

Missed Term Test: If a student is experiencing a serious personal illness or emergency on the date of the test, the student **must declare their absence on ACORN and notify the teaching team via email no later than one week after the date of the test.** If a student misses the term test for a valid reason then the weight of the term test (30%) will be shifted to the weight of the final exam. In such case, the weight of the final exam will be 80%.

Extension request policy

Extreme Situations/Prolonged Illness: Should a student be experiencing a prolonged illness or other situation that prevents them from turning in their work, they should immediately contact their instructor and College Registrar to inform them of their situation.They should also submit an Absence Declaration form on ACORN or a Verification of Illness (VOI) form that lists every day during which they were incapacitated

and unable to work. Accommodations will not be considered without a completed declaration or VOI, and will only be considered for extreme circumstances at the request of the College Registrar.

Accessibility-Related Extension Requests: Students registered with Accessibility Services should notify the instructor as soon as possible if additional time is needed on assessments that are eligible for such accommodation. Please notify the instructor by email of your situation and cc your accessibility advisor in the process. The instructor will work with the accessibility advisor to determine an appropriate accommodation for your situation.

Regraded requests

Regrade requests will be accepted for all assessments. Regrade requests must provide a justification for where there exists a grading error and/or how the work meets the grading rubric. These justifications must further be backed up with concrete references to the course materials. All regrade requests will be accepted by email and will be accepted no later than one week after the grade for that assessment is released. No regrade requests will be accepted after the 1 week deadline. The instructor further reserves the right to re-evaluate the assessment in its entirety (i.e. grades can go up, down, or remain unchanged). Please allow 2 weeks for regrade requests to be processed by the instructor.

Intellectual property

Course materials provided on Quercus, such as lecture slides, assessments, and solutions are the intellectual property of your instructor or TAs and are for the use of students currently enrolled in this course only. In class lectures and tutorials might be recorded and be made available to other students enrolled in the course. **Providing course materials to any person or company outside of the course is unauthorized use and violates copyright.**

Use of artificial intelligence

ChatGPT and other generative AI tools can perform a variety of functions for us. However, students **cannot** use ChatGPT and other AI tools in their online quizzes. The instructor reserves the right to ask students to explain their solutions in the online quizzes.

Academic integrity

The University treats cases of plagiarism and cheating very seriously. It is the students' responsibility for knowing the content of the University of Toronto's Code of Behaviour on Academic Matters. All suspected cases of academic dishonesty will be investigated following procedures outlined in the above document. If you have questions or concerns about what constitutes appropriate academic behaviors or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see `http://academicintegrity.utoronto.ca/`).

Accessibility needs

The University of Toronto offers academic accommodations for students with disabilities. If you require accommodations, or have any accessibility concerns about the course, the classroom, or course materials, please contact Accessibility Services as soon as possible: accessibility.services@utoronto.ca or `http://accessibility.utoronto.ca`.

Tentative schedule of topics

Below is a tentative schedule of topics. The schedule is subject to change and refinement as needed.

Week	**Topics**	**Book Chap.**	**Activities**
Week 1 (July 3)	Course Overview and Introduction to Probability Theory	1	Initial Survey
Week 2 (July 8, 10)	Expectation and Variance; Bayes Rule and Independence; Discrete Random Variables and Continuous Random Variables	2–3	Quiz (Jul. 13) & Simulation Challenge (Jul. 15)
Week 3 (July 15, 17)	Transformations of Random Variables; Simulation of Distributions; Joint Distributions; Covariance and Correlation (with real-world data)	2–3	Quiz (Jul. 20) & Simulation Challenge (Jul. 22)
Week 4 (July 22, 24)	Law of Large Numbers and Central Limit Theorem via Simulation; Review for Midterm	4	Midterm Test & Midterm Survey
Week 5 (July 29, 31)	Bootstrapping for Confidence Intervals; Hypothesis Testing as a Decision Process; Basic Bayesian Thinking (Prior to Posterior Updates)	6.4 & 7 & 8.2	Quiz (Aug. 3) & Simulation Challenge (Aug. 5)
Week 6 (August 5, 7)	Point Estimation, Interval Estimation, Building and Evaluating Estimators (Bias, Consistency)	6	Quiz (Aug. 10) & Simulation Challenge (at Aug. 12)
Week 7 (August 12)	Statistical Models; Wrap-up and review	5	