STA305H1 S

Design and Analysis of Experiments

Summer 2025 Syllabus

Course Meetings

STA305H1 S

Section	Day & Time	Delivery Mode & Location
LEC0101	Tuesday, 11:00 AM - 2:00 PM Thursday, 11:00 AM - 2:00 PM	In Person: PB B250 In Person: PB B250

Refer to ACORN for the most up-to-date information about the location of the course meetings.

Course Contacts

Course Website: https://q.utoronto.ca/courses/389421

Instructor: Omidali Aghababaei Jazi
Email: omid.jazi@utoronto.ca
Office Hours and Location: Tuesday & Thursday, 10:00 AM- 11:00 AM, Zoom, Meeting ID: 851 2743 5677, Passcode: STA305

Course Overview

Experiments vs observational studies, experimental units. Designs with one source of variation. Complete randomized designs and randomized block designs. Factorial designs. Inferences for contrasts and means. Model assumptions. Crossed and nested treatment factors, random effects models. Analysis of variance and covariance. Sample size calculations.

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Course Learning Outcomes

1. Understand the fundamental principles of experimental design.
2. Identify appropriate experimental designs for different research questions.
3. Apply statistical methods for analyzing experimental data using R.
4. Interpret results of experiments in the context of real-world problems.
5. Evaluate assumptions underlying statistical models used in experimental design and conduct appropriate diagnostics.

Prerequisites: STA302H1/STAC67H3/STA302H5

Corequisites: None
Exclusions: STAC50H3, STAC53H3, STA305H5
Recommended Preparation: None
Credit Value: 0.5

Course Materials

Textbook: Design and Analysis of Experiments and Observational Studies using R, by Nathan Taback, CRC Press, 2022. It's available here and here.

Additional References:

1. Design and Analysis: A Researcher's Handbook, 4th edition, by Keppel & Wickens.
2. Statistics for Experimenters: Design, Innovation, and Discovery. Box, G.E.P., Hunter, J.S., Hunter, W.G. Wiley 2nd Ed. 2005
3. Design and Analysis of Experiments. Dean, A., and Voss, D. Springer. 1999. http://go.utlib.ca/cat/2573215
4. Design of Observational Studies. Rosenbaum, P. R. Springer 2010. UofT link to electronic copy: http://go.utlib.ca/cat/7890274
5. Experiments: planning, analysis, and optimization. Wu, C.F.J., Hamada, M.S. Wiley, 2009, 2nd ed., http://go.utlib.ca/cat/8598479

Statistical Computing:

We will use R for all examples. R is freely available for download https://cran.r-project.org for Windows, MacOS, and Linux operating systems. For the assessments, you will need to know how to interpret output from R and understand R codes. RStudio is a fantastic integrated development environment (IDE) for R. It is freely available at https://www.rstudio.com/products/rstudio/. The R syntax for all examples in lecture will be provided which should be sufficient for you to complete the assessments. You are encouraged to access R/RStudio through https://jupyter.utoronto.ca/ by logging with your UTORid.

Marking Scheme

Assessment	Percent	Details	Due Date
Term Test	24%	In-person, Tuesday, July 22nd, 11:15 AM-12:45 PM.	2025-07-22
Assignments	24%	Bi-weekly, online (crowdmark).	No Specific Date
In-Person Final Exam	52%		Final Exam Period

Term Test: The term test will be held in-person on Tuesday, July 22nd, 11:15 AM-12:45 PM. Other details such as the content and the location will be announced on Quercus approximately a week before the test.

Assignments: There will be three assignments that must be completed individually. They are opportunities to practice and receive feedback on problems. Students must use RMarkdown to create pdf format documents that contain R code, equations, visualizations and text. Students are expected to solve all questions. However, all the questions may or may not be marked. Assignments must be submitted through Crowdmark. Submission via other methods such as email or Quercus will NOT be accepted. Requests for a deadline extension will be granted under extenuating circumstances. Other details about each assignment will be posted on Quercus.

Final Exam: The final exam will be in-person, last 3 hours, and from the entire material. The exact date and time will be scheduled and announced by the Office of the Faculty Registrar (OFR).

Late Assessment Submissions Policy

Late submissions (within 12 hours after a due date) will receive a penalty of 5% per hour.

Course Schedule

Weeks	Topics	Term Work
Week 1 (Jul. 02 - Jul. 04)	Introduction, Basic Concepts in Design of Experiments, Mathematical Statistics: Simulation & Computation	Assignment 1
Week 2 (Jul. 07 - Jul. 11)	Comparing Two Treatments	
Week 3 (Jul. 14 - Jul. 18)	Power and Sample Size	Assignment 2
Week 4 (Jul. 21 - Jul. 25	Comparing More Than Two Treatments	Term Test
Week 5 (Jul. 28 - Aug. 01)	Comparing More Than Two Treatments	Assignment 3
Week 6 (Aug. 04 - Aug. 08)	Factorial Designs at Two Levels	
Week 7 (Aug. 11- Aug. 12)	Causal Inference	

Policies & Statements

Missed Term Work

Missed Assignments will earn a mark of zero, without exception. Reasons/justification for missing the assignments will not be accepted.

For missed term test, students must provide valid documentation, that is the Verification of Illness or Injury. The documentation must be sent to the course instructor (omid.jazi@utoronto.ca) within seven days of the missed term test.

Once per semester, each student is allowed to miss work without any documentation. In that case you must fill out the ACORN absence declaration form. The form can be used at most ONCE per semester (once in total for all your courses, not once per course). The absence you declare can be for a maximum of 7 consecutive days. If you use the ACORN absence declaration form, you do not need to submit any documentation for missed work during that absence.

There is NO make-up test in this course. For missed term test with valid documentation or absence declaration, the weight will be shifted to the final exam's weight.

Late Term Work

Late submissions (within 12 hours after a due date) will receive a penalty of 5% per hour.

Academic Integrity

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters (https://governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019). If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, please reach out to me. Note that you are expected to seek out additional information on academic integrity from me or from other institutional resources. For example, to learn more about how to cite and use source material appropriately and for other writing support, see the U of T writing support website at http://www.writing.utoronto.ca. Consult the Code of Behaviour on Academic Matters for a complete outline of the University's policy and expectations. For more information, please see A&S Student Academic Integrity (https://www.artsci.utoronto.ca/current/academic-advising-and-support/student-academic-integrity) and the University of Toronto Website on Academic Integrity (https://www.academicintegrity.utoronto.ca).

Re-marking Policy - Timeline and Protocol

The course re-mark policy exists to correct mistakes, and any request should clearly identify the error (for example, a question that was not marked, or a total incorrectly calculated). Requests to correct such mistakes must be sent by email to the instructor. Before you request for a re-mark, please make sure you know the correct solutions posted in Quercus.

To be considered for a re-mark,

- students should make such requests within one week after their mark were returned.
- the email should include student's full name and ID number and give a specific and concise reason for each request, referring to a possible error or omission by the marker. Remarking requests without a specific reason will not be accepted.

Note that if a student requests for a re-mark, the entire assignment/term test may be re-marked. So, the new grade may go up, go down, or remain the same.

Informed Consent – Email Lists

As a student enrolled in this course, you understand that you are providing your implicit consent to be included in an email list for the department to send you non-essential information from time to time. If you do not wish to be included in such an email list, please request to be removed by contacting one of the Academic Advisors & Undergraduate Program Administrators.

Students with Disabilities or Accommodation Requirements

Students with diverse learning styles and needs are welcome in this course. If you have an acute or ongoing disability issue or accommodation need, you should register with Accessibility Services (AS) at the beginning of the academic year by visiting https://studentlife.utoronto.ca/department/accessibility-services/. Without registration, you will not be able to verify your situation with your instructor, and instructor will not be advised about your accommodation needs. AS will assess your situation, develop an accommodation plan with you, and support you in requesting accommodation for your course work. Remember that the process of accommodation is private: AS will not share details of your needs or condition with any instructor, and your instructor will not reveal that you are registered with AS.

Additional Content

Use of Generative AI: Students may use artificial intelligence tools, including generative AI, in this course as learning aids. However, students are ultimately accountable for the work they submit

Piazza: Piazza will be used for discussions. This is for student-led discussion. The instructor and the TAs will check Piazza posts on a regular basis and might participate in discussions. Please do not email questions about course content to the instructor/TAs. Instead, post your question on Piazza. Volume of messages increases one or two days before the test. It will not be possible for the instructor and/or the TAs to answer the questions.

Email Policy: Email is most appropriate for personal questions. Before you send an e-mail, make sure that you are not asking for information that is already on the course outline/ website/announcements, or questions about the course material that are more appropriately discussed during office hours. If you do not get a response, this may be why. If your question is conceptual and does not require calculations or an elaborate answer, you can ask by email. For all other matters, contact the instructor. Please email the instructor and TAs using your U of T email address. The subject line should contain the course number, lecture section number, and a relevant subject (indicating what the email is about). Be sure to include your full name and student number in the body of the message. You will not get a response if you email from other email addresses or do not follow the email policy.

Privacy and Use of Course Materials Notifications: Course materials belong to your instructor, the University, and/or other source depending on the specific facts of each situation and are protected by copyright. In this course, you are permitted to download session materials for your own academic use, but you should not copy, share, or use them for any other purpose without

the explicit permission of the instructor. For questions about recording and use of videos in which you appear please contact your instructor.

Student Responsibilities:

- It is up to students to know all course policies and important dates. It is also up to them to know about any important announcements; these will come to their inbox. Check Quercus regularly!
- Students are responsible for their own learning. The instructor/TAs are happy to help them learn, but in the end, it is up to them. Use office hours and Piazza often. Make an appointment with the instructor. Keep asking questions until you are satisfied. Ask about big concepts or small details there is no such thing as a stupid question. Always take advantage of extra help and don't wait until it is too late.
- Students must follow the U of T code of Behaviour this means that cheaters will be prosecuted. The Academic Regulations of the University are outlined in the Code of Behaviour on Academic Matters. They are expected to be familiar with, and to abide by, all components of the Code of Behaviour on Academic Matters. Full details can be found here.

Instructor/TAs Responsibilities:

- Lectures will be clearly presented, organized, and have plenty of examples.
- Office hours and Piazza can help students solve problems and solidify their learning.
- Extra help, remedial and acceleration are always available during office hours, by appointment, and by email.
- Students' emails will be answered in a timely fashion, typically within 48 weekday (business) hours.
- Every student will be treated with fairness and respect. Students who wish to excel are encouraged. Students who abuse the U of T code of behavior will be dealt with appropriately.

Course Topics: This course plans to cover the following topics from the textbook.

Chapter 1: Introduction
- 1.1 - Why Design Scientific Studies?

Chapter 2: Mathematical Statistics: Simulation and Computation
- 2.1 - Data
- 2.2 - Frequency Distributions
- 2.3 - Randomization
- 2.4 - Theoretical Distributions
- 2.5 - Quantile-Quantile Plots
- 2.6 - Central Limit Theorem
- 2.7 - Statistical Inference
- 2.8 - Linear Regression
- 2.9 - Randomized Experiments and Observational Studies
- 2.10 - Principles of Experimental Design

Chapter 3: Comparing Two Treatments
- 3.1 - Introduction
- 3.2 - Treatment Assignment Mechanism and Propensity Score

- 3.3 - Completely Randomized Designs
- 3.4 - The Randomization Distribution
- 3.5 - The Randomization p-value
- 3.6 - Randomization Distribution of a Test Statistic
- 3.7 - Computing the Randomization Distribution using Monte Carlo Sampling
- 3.8 - Properties of the Randomization Test
- 3.9 - The Two-sample t-test
- 3.12 - Randomized Matched Pairs Design
- 3.14 - The Randomization Test for a Randomized Paired Design
- 3.15 - Paired t-test

Chapter 4: Power and Sample Size
- 4.1 - Introduction
- 4.2 - Statistical Hypotheses and the Number of Experimental Units
- 4.3 - Power of the One-Sample z-test
- 4.4 - Power of the One-Sample t-test
- 4.5 - Power of the Two-Sample t-test
- 4.6 - Power and Sample Size for Comparing Proportions
- 4.6 - Calculating Power by Simulation

Chapter 5: Comparing More Than Two Treatments
- 5.1 - Introduction: ANOVA-Comparing More Than Two Groups
- 5.2 - Random Assignment of Treatments
- 5.3 - ANOVA
- 5.4 - Estimating Treatment Effects Using Least Squares
- 5.5 - Computation Lab: Estimating Treatment Effects Using Least Squares
- 5.6 - Multiple Comparisons
- 5.7 - Sample Size for ANOVA-Designing a Study to Compare More Than Two Treatments
- 5.8 - Randomized Block Designs
- 5.9 - The Linear Model for Randomized Block Design
- 5.10 - Latin Square Design
- 5.11 - Statistical Analysis of Latin Square Designs
- 5.12 - Graeco-Latin Square Designs

Chapter 6: Factorial Designs at Two Levels-2^k Designs
- 6.1 - Introduction
- 6.2 - Factorial Effects
- 6.3 - Replication in Factorial Designs
- 6.4 - Linear Model for a 2^k Factorial Design
- 6.5 - Normal Plots in Unreplicated Factorial Design
- 6.6 - Lenth's Method
- 6.7 - Blocking Factorial Designs
- 6.8 - Fractional Factorial Designs (if time permits)

Chapter 7: Causal Inference
- 7.1 - Introduction: The Fundamental Problem of Causal Inference
- 7.2 - Treatment Assignment
- 7.3 - Causal Effects and Randomized Experiments
- 7.4 - Causal Effects and Observational Studies

Term Work Schedule: This schedule is tentative and subject to change. Updates will be posted on Quercus.

Term Work	Availability & Deadline	Content
Assignment 1	Fri. July 4th, 9:00 AM - Sun. July 13th, 11:59 PM	Chapters 1, 2, 3
Assignment 2	Mon. July 14th, 9:00 AM - Sun. July 27th, 11:59 PM	Chapters 4, 5
Term Test	Tuesday July 22nd, 11:15 AM- 12:45 PM	TBA
Assignment 3	Mon. July 28th, 9:00 AM - Mon. August 11th, 11:59 PM	Chapters 5-6