

Winter 2024 | ECOR 2050: Design and Analysis of Engineering Experiments
Carleton University
Department of Civil and Environmental Engineering

Teaching Team

Instructor:

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Office: Mackenzie 4242

Office Hours

TBD

TAs:

Information to be announced on Brightspace.

Course Description and Requirements

1. Schedule

Lectures

Lecture	Day	Time	Building/Room*
Section C	Tuesday/Thursday	10:05 am – 11:25 am	Loeb C164
Section D	Tuesday/Thursday	11:35 am – 12:55 pm	Loeb C164

*Please refer to the [Public Class Schedule](#) for the most recent information

Labs/Tutorials

Lab sessions (tutorials) will be run by teaching assistants (TAs), **starting January 22** (subject to change, depending on TA availability). During these sessions, TAs will solve example problems that help you prepare for assignments and exams and will also teach you how to utilize statistical functions and create plots in Microsoft Excel. At the end of each session, the TA will hold a 1-hour office hour to answer your questions. Attending labs is not mandatory but highly recommended.

2. Course Description

Engineering designs and decisions are often made under uncertainty because engineers do not have the resources (time, money,..) to conduct every experiment and obtain all of the data of interest of the project to support their decisions/designs. Statistics and probability concepts are used to quantify this uncertainty by designing experiments and properly collecting, analyzing and interpreting data in a way that can reduce the risk and improve the reliability in our design and decision making.

3. Intended Learning Outcomes

Upon the completion of this course, you should be able to:

- Describe and calculate common statistical parameters and construct experimental plots
- Explain basic probability concepts and follow continuous probability distributions (normal distribution)
- Identify between samples and populations and follow central limit theorem and sampling distributions (z, t, chi-squared, and F distributions)
- Apply statistical and probabilistic analysis to estimate population parameters (mean and variance) based on experimental data/samples
- Test hypotheses about population parameters (mean and variance) based on experimental data/samples, and conduct multiple-comparison problems
- Implement randomized experimental design to collect unbiased and independent data/samples for statistical analysis (analysis of variance), comparing population means and investigating effects of one or two factors
- Formulate simple linear regression analysis to build empirical models
- Interpret resulting data to obtain objective conclusions and communicate the results effectively

4. Graduate Attributes (GAs)

The Canadian Engineering Accreditation Board (CEAB) requires graduates of undergraduate engineering programs to possess 12 attributes. Courses in all four years of our programs evaluate students' progress towards acquiring these attributes. Aggregate data (typically, the data collected in all sections of a course during an academic year) is used for accreditation purposes and to guide improvements to our programs. Some of the assessments used to measure GAs may also contribute to final grades; however, the GA measurements for individual students are not used to determine the student's year-to-year progression through the program or eligibility to graduate. This following list provides the GAs that will be measured in this course, along with the Learning Outcomes that are intended to develop abilities related to these attributes.

GA - Indicator	Assessment Tool
1.1 - Mathematical skills	Overall course grade
3.1 - Complex problem assessment	some assignment question(s), including a mini project
3.2 - Design of experiments	
3.3 - Experimental procedure	
3.4 - Data reduction methods and results	
3.5 - Interpretation of data (synthesis) and discussion	

For information on GAs and continual curriculum improvement, visit the [Accreditation section of Engineers Canada website](#).

5. Accreditation Units

Math/Stats	Natural Science	Complementary Studies	Engineering Science	Engineering Design
50%	-	-	50%	-

6. References

Recommended Textbooks

1. Walpole R.E., Myers, R.H., Myers, S.L., Ye, K.E. Probability and Statistics for Engineers and Scientists. 9th Edition. 2010, Pearson.
2. Montgomery D.C. and Runger G.C., Applied Statistics and Probability for Engineers. 7th Edition. 2018, John Wiley & Sons, Inc.
3. Montgomery D.C., Runger G.C., and Hubele, N.F. Engineering Statistics. 5th Edition, 2010, John Wiley & Sons, Inc.
4. Montgomery. D.C., Design and Analysis of Experiments. 8th Edition. John Wiley & Sons, Inc.

Lecture Notes

Lecture notes will be posted **periodically** on Brightspace. The notes are designed to supplement lectures, but do not represent the complete content of the course (for that you should attend the lectures). Some sections of the notes are left blank. We will fill them throughout lectures but filled notes will not be provided. Please be prepared to fill in your notes by hand, tablet, computer, or any approach you find works best for you.

Lectures will not be recorded by the instructor and students do not have permission to record lectures on their own unless it is a part of their PMC accommodation (with required documentation).

7. Topics and Tentative Plan

Week		Anticipated Topic*	Assessment*
1	Jan. 8-12	Chapter 1: Exploratory Data Analysis: statistics in engineering, descriptive statistics, graphing experimental data, introduction to population and sampling	
2	Jan. 15-19		
3	Jan. 22-26	Chapter 2: Probability Concepts and Distribution: basic probability concepts, random variables, probability density function and probability mass function, normal distribution	
4	Jan. 29-Feb. 2		A1 (CH 1), Feb. 5
5	Feb. 5-9	Chapter 3: Sampling: sampling design, central limit theorem, sampling distribution of mean (z and t distributions), sampling distribution of variance (chi-squared distribution), F distribution, point and interval estimation, confidence interval, replication, and sample size	
6	Feb. 12-16		A2 (CH 2), Feb. 16
7	Feb. 26-Mar. 1		
8	Mar. 4-8	Chapter 4: Hypothesis Testing: terminology and definitions, hypothesis testing for population parameters and multiple-comparison problems (t-test, chi-squared test, F-test), p-value, Type I and Type II error	A3 (CH 3), Mar. 4
9	Mar. 11-15		Midterm**
10	Mar. 18-22	Chapter 5: Basics of Design of Experiments: terminology, replication and randomization, experiments with a single factor, introduction to blocking and factorial design, two-factor experiments, analysis of variance	
11	Mar. 25-29		A4 (CH 4), Mar. 25
12	Apr. 1-5	Chapter 6: Regression Analysis: simple linear regression, prediction confidence, diagnostic tests concerning linear regression (correlation, ANOVA, residual plots, slope)	
13	Apr. 8-10	Review	A5 (CH 5&6), Apr. 8 (includes a mini project)

* Subject to change

** Midterm will be between March 9 to March 17. The exact date will be decided based on the most popular date determined by survey results.

8. Evaluation and Marking Scheme

Your overall course grade will be determined using the following scheme:

Assignments including a mini project	Midterm	Final
15%	30%	55%

Homework Assignments

To aid your mastery of the course concepts and help prepare you for exams, problems will be assigned as 5 assignments. Last assignment includes a **mini project**. Marks are awarded for a complete and proper writing of the solution (including units, assumptions, conclusion statements, etc.), not just the right answer.

Midterm

Midterm will be between March 9 to 17. The exact date will be decided based on the most popular date determined by survey results. It will be an individual closed book test on **Chapter 1 to 3**. Marks are awarded for a complete and proper writing of the solution, **not just the right answer**.

Final Exam

This course has a **two-hour** final exam (to be scheduled in the final exam period) which will be an individual **closed book** test on **all the chapters**. Use of **non-programmable** calculators is allowed. Marks are awarded for a complete and proper writing of the solution, **not just the right answer**.

Policies

a) Final Examination

- i. Final exams are for evaluation purpose and will not be returned to students.
- ii. Students who are unable to write the final examination because of a serious illness/emergency or other circumstance beyond their control may apply for accommodation by contacting the Registrar's office. Consult the [Section 4.3 of the University Calendar](#).

b) Assignment Late Submission Policy

Assignments should be submitted by the due date. If you cannot meet a deadline, please make arrangements with the instructor **before** the deadline; otherwise a penalty of **10% per day** will be deducted from your grade up to **2 days** or until the solution set is posted. **Late submissions are not accepted after solution set is posted and will result in a grade of zero**, unless appropriate documentation is provided.

c) Self-Declaration Form for Term-work (Midterm and Assignments)

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work or Midterm are held responsible for immediately informing the instructor concerned and for alternate arrangements with the instructor and in all cases this must occur **no later than three (3) days after the term work was due or Midterm date**. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. Consult [Section 4.4 of the University Calendar](#).

d) Appeals

You should bring any grading appeals to your instructor's attention **within 7 days** of grades being posted. A brief description of your concern should be submitted in an email to your instructor. Teaching Assistants will not change any marks.

9. Academic Dates

Students should be aware of the academic dates (eg. last day for academic withdrawal) posted on the Registrar's office web site <https://carleton.ca/registrar/registration/dates/academic-dates/>

Academic Integrity and Plagiarism

- a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: <https://carleton.ca/engineering-design/current-students/fed-academic-integrity> Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or, expulsion.
- b) One of the main objectives of the Academic Integrity Policy is to ensure that **the work you submit is your own**. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as “presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one’s own.” This includes reproducing or paraphrasing portions of someone else’s published or unpublished material, regardless of the source, and presenting these as one’s own without proper citation or reference to the original source.

Examples of violations of the policy include, but are not limited to:

- any submission prepared in whole or in part, by someone else;
- using another’s data or research findings without appropriate acknowledgement;
- submitting a computer program developed in whole or in part by someone else, with or without modifications, as one’s own; and
- failing to acknowledge sources of information through the use of proper citations when using another’s work and/or failing to use quotations marks.

Copyright

The materials (including the course outline and any slides, posted notes, videos, labs, project, assignments, quizzes, exams and solutions) created for this course and posted on this web site are intended for personal use and may not be reproduced or redistributed or posted on any web site without prior written permission from the author(s).

Learning and Working Environment

The University and all members of the University community share responsibility for ensuring that the University’s educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the [Department of Equity and Inclusive Communities](mailto:equity@carleton.ca) at equity@carleton.ca

We will strive to create an environment of mutual respect for all through equity, diversity, and inclusion within this course. The space which we work in will be safe for everyone. Please be considerate of everyone’s personal beliefs, choices, and opinions.

Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at **613-520-6608** or pmc@carleton.ca.

You should request your academic accommodations in the [Ventus Student Portal](#), for each course at the beginning of every term. For in-term tests or midterms, please request accommodations at least two (2) weeks before the first test or midterm. For final exams, the deadlines to request accommodations are published in the [University academic calendars](#) for both undergraduate and graduate students.

Accommodation for Student Activities: Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the [Senate Policy on Accommodation for Student Activities \(PDF\)](#).

Pregnancy Obligation: Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF\)](#).

Religious Obligation: Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF\)](#).

Survivors of Sexual Violence: As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit the [Sexual Violence Prevention & Survivor Support](#).

Engineering Academic Advising

[The Engineering Academic Support Service](#) assists undergraduate engineering students with course selection, registration, and learning support from first-year through to graduation.

Academic Advisors Contact can be found here: <https://carleton.ca/engineering-design/current-students/undergrad-academic-support/undergraduate-advisors/>.

Student Mental Health and Wellness

As a university student you may experience a range of mental health challenges that can significantly impact your academic success and overall well-being. Carleton's [Wellness Services Navigator](#) is designed to help students connect with mental health and wellness resources.

If you need more information and support with connecting to resources, you are welcome to contact me (shoelehshams@cunet.carleton.ca, Office: 4242 Mackenzie)

Here is a list of on-campus and off-campus resources:

1. **Carleton's Wellness Desk:** Located at [204A MacOdrum Library](#), is a space for students to learn about resources, connect with our Wellness Coordinator, and decompress during stressful times of the year. You can pop into the Wellness Desk any time during its hours of operation – no appointments necessary! <https://wellness.carleton.ca/mental-health/wellness-desk/>
2. **Carleton's Health and Counselling Services:** To book an appointment contact the main clinic by calling (613) 520-6674. If urgent, let the Patient Care Coordinator know or go in person to the main clinic (2500 Carleton Technology and Training Centre Building) and indicate that they are in crisis and need to speak to someone right away. For more information, please see <https://carleton.ca/health/>
3. [Emergencies and Crisis](#) and [Emergency Numbers](#)
4. **Good2Talk (1-866-925-5454):** Good2Talk is a free, confidential helpline providing professional counselling and information and referrals for mental health, addictions and well-being to post-secondary students in Ontario, 24/7/36 <https://good2talk.ca/>
5. **Empower Me:** Undergraduate students have access to free counselling services in the community through Empower Me, either in person, by telephone, video-counselling or e-counselling. **This free service is accessible 24/7, 365 days per year.** Call **1-844-741-6389 (toll free)** to make an appointment with a counsellor in the community. More information is available <https://students.carleton.ca/services/empower-me-counselling-services/>
6. **The Walk-In Counselling Clinic (off-campus community resource):** The walk-in Counselling Clinic have offices in various locations across Ottawa and the greater Champlain region that are open 7 days a week. Individuals will be assisted, with no appointment, on a first-come, first-serve basis during the Walk-in Counselling Clinic hours. The Walk-in Counselling Clinic **offers services in many languages** and is free and confidential. More information can be found at: <https://walkincounselling.com/>
7. **Distress Centre of Ottawa and Region:** Available 10am-11pm, 7 days/week, 365 days/year. **Distress Line:** 613-238-3311, **Crisis Line:** 613-722-6914 or 1-866-996-0991, **Text:** 343-306-5550. <https://www.dcottawa.on.ca/>
8. **Distress and Crisis Ontario,** Available for chat 2 pm – 2 am EST. <https://www.dcontario.org/>
9. **BounceBack Ontario** (Toll-Free: 1-866-345-0224) is a free skill-building program managed by the Canadian Mental Health Association (CMHA). It is designed to help adults and youth 15+ manage low mood, mild to moderate depression and anxiety, stress or worry. Delivered over the phone with a coach and through online videos, you will get access to tools that will support you on your path to mental wellness. <https://bouncebackontario.ca/>