

STAT 430/830: EXPERIMENTAL DESIGN SPRING 2020

INSTRUCTOR INFORMATION

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Office Hours: Fridays: 10:00AM – 2:00PM (EST)

COURSE DESCRIPTION

This course introduces students to the design and analysis of experiments with emphasis on practical application. Students will become familiar with the fundamental design principles of replication, blocking, randomization, and sequential problem solving. Technical topics include the design and analysis single factor experiments, multi-factor experiments such as full-factorial, 2^k factorial and 2^{k-p} fractional factorial experiments. Randomized block designs in each case will also be considered. Advanced topics such as split-plot designs and the optimal design of experiments will be covered if time allows. Students will use the statistical software R throughout the course to illustrate the importance and utility of automating both the design and analysis of experiments.

COURSE OBJECTIVES

Any student who successfully completes this course should be able to:

- Accurately define a problem statement and think critically and methodically about the design of an experiment that can help solve said problem.
- Acknowledge that an experiment is not the most appropriate solution to every problem and understand the limitations of experimentation.
- Describe the advantages of randomization, replication, and blocking in an experimental context.
- Design and analyze single factor, multi-factor, factorial, fractional factorial, randomized block and response surface experiments.
- Demonstrate competence with devising computational solutions to the design and analysis of experiments using R.
- Communicate the results of an experiment in a clear and coherent manner.
- Appreciate the relevance of experimentation in a variety of fields including applied statistics, data science, engineering, physical sciences, social sciences and healthcare.

COURSE TOPICS

1. Experimentation fundamentals
 - PPDAC
 - Replication, randomization, blocking
2. Single factor experiments
 - Two-level experiments (A/B testing)
 - Multi-level experiments (A/B/n testing)
3. Randomized block designs
 - Complete blocks designs and Latin squares
4. Multi-factor experiments
 - Factorial experiments (multivariate tests)
5. Two-level factorial and fractional factorial experiments
 - Screening designs
 - Blocking two-level designs
6. Response surface methodology
 - Sequential experimentation + path of steepest ascent
 - Response optimization + second order models and designs
7. Split-plot designs*
8. Use of R (as it pertains to the content listed above)
 - *time permitting

LECTURES

Course content will be delivered in weekly video installments. Videos will typically be posted on Mondays and they will be composed of me talking while annotating typeset notes and performing analysis demonstrations in R. All relevant notes, datasets and R files will be posted at the same time as the corresponding videos.

FAQ FRIDAYS

Every Friday, from 10:00AM – 2:00PM (EST), I will hold virtual office hours via Zoom. Throughout each week I will curate all of the frequently asked questions in Slack and at the beginning of each FAQ Friday session I will answer all of these questions (this will be recorded for those who can't attend live). The remaining time will be devoted to a drop-in style Q&A like ordinary office hours.

COURSE HOMEPAGE

The course homepage is on LEARN (<https://learn.uwaterloo.ca>). All course material will be posted here. It is my expectation that you regularly visit this webpage to download course material and receive important announcements.

COURSE COMMUNICATION

Although you may email me (please ensure these come from your “uwaterloo” email address) the primary mode of communication amongst yourselves, myself and the TAs, will be with Slack, a workplace instant-messaging app. All discussions will take place within the STAT430-Spring2020 workspace. Login using your “uwaterloo” email address and the workspace URL “stat430spring2020” at <https://slack.com/signin>. To join the workspace, you must click the invite link below:

[CLICK HERE TO JOIN SLACK FOR STAT 430/830](#)

TEXTBOOK

There is no required textbook for this course. Instead, I will provide written course notes that blend material from the sources listed below. Each of these books is excellent, but it is my opinion that none on their own is sufficient for this course.

You will be assigned weekly readings from my course notes, but if you would like to supplement these readings, feel free to consult these books. Note that the books are ordered on a spectrum from more statistical to more applied.

- *Experiments: Planning, Analysis, and Optimization*, 2nd edition
C.F.J. Wu and M. Hamada, Wiley.
- *Design and Analysis of Experiments*, 10th edition
D.C. Montgomery, Wiley.
- *Response Surface Methodology: Product and Process Optimization Using Designed Experiments*, 4th edition
R.H. Myers, D.C. Montgomery and C.M. Anderson-Cook, Wiley.
- *Optimal Design of Experiments*
P. Goos and B. Jones, Wiley.
- *Design of Comparative Experiments*
R.A. Bailey, Cambridge
- *Statistical Methods in Online A/B Testing*
G.Z. Georgiev
- *Trustworthy Online Controlled Experiments*
R. Kohavi, D. Tang and Y. Xu, Cambridge.
- *Experiment! Website conversion rate optimization with A/B and multivariate testing*
C. McFarland, New Riders
- *A/B Testing: The Most Powerful way to Turn Clicks into Customers*
D. Siroker and P. Koomen, Wiley.
- *Experimentation Works*
S. Thomke, Harvard Business Review Press

ASSESSMENT

1. Assignments (60%)

- There will be four (4) assignments, each worth 15% of your final grade. Assignments will consist of hand calculations, proofs, definitional questions, short answer responses and analyses in R.
- You will have two weeks to complete each assignment – their release dates and due dates are shown in the table below.
- Assignments will be submitted electronically via Crowdmark by 11:59PM (EST) on the due dates shown below.

Assignment	Release Date	Due Date
1	Friday May 15	Friday May 29
2	Friday June 5	Friday June 19
3	Friday June 26	Friday July 10
4	Friday July 17	Friday July 31

- You are expected to complete these assignments **independently** and submit your own work. Cheating is a serious offence and will be treated as such. Please refer to the Academic Integrity section below.
- If you fail to submit an assignment and have a **valid** reason with supporting documentation, the 60% Assignment weight will be redistributed across the remaining assignments.
- If your reason for incompleteness is not deemed valid, or you do not have supporting documentation, you will receive a zero. Note that for your circumstance to be deemed valid, you must have been incapacitated for the *majority* of the two-week timeframe between the assignment's release date and due date.
- Note that for all accommodations due to illness, a [University of Waterloo Verification of Illness Form](#) (VIF) is the documentation I require.
- **Assignments up to 24 hours late will receive a penalty of 50%. Assignments more than 24 hours late will not be graded, and you will receive a zero.**
- If you have a dispute with your grade on an assignment, it may be submitted to be remarked within 1 week of the assignment being returned to you. Bear in mind that the entire assignment is then subject to be remarked.

2. Quizzes (20%)

- There will be twelve (12) weekly quizzes, the best ten (10) of which will each be worth 2% of your final grade. These small quizzes are intended to test your comprehension of the lecture material and weekly readings.
- The quizzes will be composed of multiple choice, true/false, matching, fill-in-the-blank, and hand calculation type questions.

- Quizzes will be administered via Möbius and will open and close on the dates outlined in the table below. Once opened, you will have 30 minutes to complete the quiz.

Quiz	Open Date/Time	Close Date/Time
1	Tuesday May 19, 12:00AM	Wednesday May 20, 11:59PM
2	Tuesday May 26, 12:00AM	Wednesday May 27, 11:59PM
3	Tuesday June 2, 12:00AM	Wednesday June 3, 11:59PM
4	Tuesday June 9, 12:00AM	Wednesday June 10, 11:59PM
5	Tuesday June 16, 12:00AM	Wednesday June 17, 11:59PM
6	Tuesday June 23, 12:00AM	Wednesday June 24, 11:59PM
7	Tuesday June 30, 12:00AM	Thursday July 2, 11:59PM
8	Tuesday July 7, 12:00AM	Wednesday July 8, 11:59PM
9	Tuesday July 14, 12:00AM	Wednesday July 15, 11:59PM
10	Tuesday July 21, 12:00AM	Wednesday July 22, 11:59PM
11	Tuesday July 28, 12:00AM	Wednesday July 29, 11:59PM
12	Tuesday August 4, 12:00AM	Wednesday August 5, 11:59PM

* Note: all times are Eastern Standard Time

- You are expected to complete these quizzes **independently** and submit your own work. Cheating is a serious offence and will be treated as such. Please refer to the Academic Integrity section below.
- If you fail to complete a quiz and have a **valid** reason with supporting documentation, the 20% Quiz weight will be redistributed across the remaining quizzes.
- If your reason for incompleteness is not deemed valid, or you do not have supporting documentation, you will receive a zero. Note that for your circumstance to be deemed valid, you must have been incapacitated for the *majority* of the two-day timeframe between the quiz's open and close time.
- Note that for all accommodations due to illness, a [University of Waterloo Verification of Illness Form](#) (VIF) is the documentation I require.

3. Final Project (20%)

- There will be a cumulative final project in this course. You will interact with a simulated response surface and you will design, conduct, and analyze a series of experiments. The results of your experimental journey will be documented in a final report that is to be submitted via Crowdmark by

11:59PM (EST) on Friday August 14

Note that the submission deadline for the project is strict; no late submissions will be accepted.

- If you do not complete the final project, you will simply receive a zero on this assessment component; no reweighting of your final grade will be considered.

INSTITUTIONAL REQUIRED STATEMENTS

Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [See the [Office of Academic Integrity](#) for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read [Policy 70, Student Petitions and Grievances, Section 4](#). When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. [See the [Office of Academic Integrity](#) for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to [Policy 71, Student Discipline](#). For typical penalties, check [Guidelines for the Assessment of Penalties](#).

Appeals: A decision made or penalty imposed under [Policy 70, Student Petitions and Grievances](#) (other than a petition) or [Policy 71, Student Discipline](#) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to [Policy 72, Student Appeals](#).

Note for students with disabilities: [AccessAbility Services](#), located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

Turnitin.com: Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit alternate assignment.