Statistical Experimental Design Statistics/Mechanical Engineering 424, Spring 2022

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office hours:	M R F 11am-12pm	M 2-3 pm	W 12-2 pm

MSC is Medical Science Center

Course Objective:

The overall goal of this course is to help you develop the conceptual foundation and practical skills needed to efficiently collect, rigorously analyze, and correctly interpret data in your future studies.

- Use the R computing language to compute and interpret test statistics, p-values, and confidence intervals associated with experiments arising from single-factor, randomized complete block, latin square, balanced incomplete block, factorial, fractional factorial, response surface, nested, and split-plot designs.
- Given a qualitative description of a scientific or engineering problem, including its intended goals and study constraints, compose an appropriate experimental design.
- Interpret computer output from comparative experiments and use it to diagnose potential failures of model assumptions.
- Recognize multiple hypothesis testing scenarios and apply appropriate corrective procedures, including Scheffe's test, Tukey's HSD, and Fisher's LSD.
- Plan and analyze experimental designs in sequential settings.

COVID-19 Context:

During the global COVID-19 pandemic, we must prioritize our collective health and safety to keep ourselves, our campus, and our community safe. As a university community, we must work together to prevent the spread of the virus and to promote the collective health and welfare of our campus and surrounding community.

Information on COVID-19 is constantly changing. Students should be attentive to University communications regarding COVID-19 that may alter instruction and supersede parts of this syllabus.

Lecture time and location

Section	Where	When
001	1651 Mosse Humanities Building	TR 1:00 - 2:15 PM
002	1227 Engineering Hall	TR 8:00 - 9:15 AM

Discussion

Attendance is strongly advised. It's the best place to ask questions in a small group, to connect with other students and form study groups, to get practice of new concepts, and get help with computing questions. Discussions will begin meeting the second week of class. If you have a laptop, we strongly recommend you bring one to discussion sections.

$\operatorname{section}$	ТА	Where	When
424-311	John Fogg	474 Van Hise Hall	M 8:50-9:40
424 - 312	Hanying Jiang	479 Van Hise Hall	M $9:55-10:45$
424 - 313	John Fogg	1143 Mechanical Engineering Building	M $4:35-5:25$
424 - 321	Bowen Zhang	3349 Engineering Hall	W $9:55-10:45$
424 - 322	John Fogg	3349 Engineering Hall	W 11:00-11:50
424-323	Bowen Zhang	3349 Engineering Hall	W $4:35-5:25$

Homework

There are 6 homework assignments. They will be posted to canvas eight days before they are due. Generally, they are due on Fridays at 4pm, two weeks apart from one another. However, Spring Break, the midterm exam, and the end of the semester alter this rhythmn slightly. The due dates are 4pm on February 11, February 25, March 11, April 8, April 22, and May 3. Note, May 3 is a Tuesday.

The homework assignment with the lowest score will be dropped. Please use this one drop policy wisely. It is there to help you when terrible things happen.

Homework assignments turned in less than 1 hour late will have 10 percentage points subtracted from their score. Homework assignments turned in more than an hour late and less than 63 hours late will have 50 percentage points subtracted from their score. For an assignment due Friday at 4pm, the last time a student can turn it in for credit is Monday at 7am. No homework can have an adjusted score of less than 0.

Here are a few examples to help you understand the homework policy.

- 1. A student has internet trouble which causes their assignment to be submitted at 4:01 PM. Their assignment is graded and earns a score of 70%, but since it was late by 1 minute the adjusted score is 60%.
- 2. A student's computer breaks on Friday, the day the homework is due. They have to get a new computer and redo all their work (unfortunately, they did not back up anything). As a result they cannot complete their assignment until Sunday. Their assignment is graded and earns a score of 60%, but since it was late by more than 1 hour and less than 63 hours, their score is 10%. Good thing there is a drop one homework assignment policy!
- 3. A student turns in their assignment on Friday at 5:01pm (they thought it was due at 5:00, not 4:00!). Unfortunately, they also didn't answer half the questions and earned a score of 40%. Since their assignment was late by more than 1 hour and less than 63 hours, their adjusted score is 0%. Good thing there is a drop one homework assignment policy!

I hope that the drop one policy will cover all family and medical emergencies that occur in our class. In the event that it does not, please reach out to me. I may be able to grant exceptions in cases of documented medical or family emergencies.

Project

There is one group project in which students will design, implement, and analyze an experiment. It is due April 15th at 4pm. Students will work in self selected (when possible) groups of 3-5 students. Project milestones will be due throughout the semester to help keep projects on track. These milestones are due January 28, February 4, February 18, March 4, and April 1.

Students will also submit evaluations of their group members. Members of a group may have their grade reduced in proportion to their failure to contribute.

The late policy for the project and project milestones is the same as that for homework. Assignments turned in less than 1 hour late will have 10 percentage points subtracted from their score. Assignments turned in more than an hour late and less than 63 hours late will have 50 percentage points subtracted from their score. However, there is no drop one policy for the project.

Exams

The midterm exam is on Thursday March 24 during class. The final exam is Monday May 9 from 12:25 pm 2:25 pm. The location of the final is yet to be determined.

Block the time for the exams now — missed exams will not be permitted except when extenuating circumstances prevail. Vacation travel does not constitute an acceptable reason for missing an exam.

Grading

The homework will count 20%, the project will count 25%, the in-class midterm exam will count 25%, and the final will count 30%. Final grades will be curved.

If you believe a mistake has been made in grading one of your submissions, you may request a regrade within one week of receiving your score. Note that the teaching team will regrade the entire submission, without reference to the original evaluation (your score may go up or down).

Computing

We will be using R and an R integrated development environment (IDE) called RStudio. R is a free, open-source, and extremely flexible package, and is available for download online at: www.cran.r-project.org/. RStudio is available for free from www.rstudio.com/products/rstudio/download/#download. No prior experience with R is expected. Access to a laptop computer is important for this class. If you do not have a laptop that can run R and Rstudio, you may use computers and laptops from the campus infolabs that have R and Rstudio installed. See: https://it.wisc.edu/services/ computer-labs-infolabs/.

Communication

Most announcements will be made at the beginning of lecture. Any changes to grading or due dates will also be posted to Canvas as announcements.

Email

- I generally reply to email once or twice a day. Please expect an email reply within 24 business hours after you sent your email. If I don't reply after 48 business hours, please send a followup. Please consider this response time and plan ahead when you contact me. If something urgent arises, you may put [URGENT] in the subject line and I will do my best to reply as soon as possible.
- If you have a question that might pertain to other students, please post it on Piazza (see below).
- If you perceive my email tone as curt, please know that really I'm very warm and fuzzy [insert cuddly emoji here]. I just get a lot of emails and I am a slow typer so I often write fewer words than are necessary to communicate a nurturing feel. If I ever offend you, please let me know so that I can try to right the wrong.

Piazza

- We will use Piazza (an app that is available through Canvas) as the main platform for asking and answering questions asynchronously.
- The Piazza forum will be the most efficient way for students to ask general questions when not in class, as it allows for asynchronous communication, and it allows for having discussions if a similar question should arise multiple times. Students are also encouraged to help other students on Piazza. Asking homework-related questions on Piazza is permitted and encouraged. However, sharing full or partial homework solutions with other students on Piazza is prohibited and may be penalized. Just ask if you don't know where the boudary between helping and giving answers is.

Online Materials

Canvas will be used to post all necessary materials, including discussion handouts and homework assignments. Canvas will also serve as a gradebook and discussion forum (via Piazza) for asking questions.

Text

Design and Analysis of Experiments, 10th Edition, Douglas C. Montgomery

Credit Information:

This course is 3 credits. The class meets for two 75-minute lecture class periods and a 50-minute discussion section each week, and carries the expectation that students will work on course learning activities (readings, homeworks, studying, etc.) for about 3 hours for every class period.

Academic Integrity

By virtue of enrollment, each student agrees to uphold the high academic standards of the University of Wisconsin-Madison; academic misconduct is behavior that negatively impacts the integrity of the

institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action. Examples of disciplinary action include, but are not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion. For detailed information, please see: https://conduct.students.wisc.edu/academic-misconduct/.

Standards of Ethical Conduct in Data Analysis and Data Privacy:

The members of the faculty of the Department of Statistics at UW-Madison uphold the highest ethical standards of teaching, data, and research. They expect their students to uphold the same standards of ethical conduct. Standards of ethical conduct in data analysis and data privacy are detailed on the ASA website: https://www.amstat.org/ASA/Your-Career/Ethical-Guidelines-for-Statistical-Practice.aspx, and include:

- Use methodology and data that are relevant and appropriate; without favoritism or prejudice; and in a manner intended to produce valid, interpretable, and reproducible results.
- Be candid about any known or suspected limitations, defects, or biases in the data that may affect the integrity or reliability of the analysis. Obviously, never modify or falsify data.
- Protect the privacy and confidentiality of research subjects and data concerning them, whether obtained from the subjects directly, other persons, or existing records.

By registering for this course, you are implicitly agreeing to conduct yourself with the utmost integrity throughout the semester.

Complaints:

If you have a complaint about a TA or course instructor, you should feel free to discuss the matter directly with the TA or instructor. If the complaint is about the TA and you do not feel comfortable discussing it with him or her, you should discuss it with the course instructor. Complaints about mistakes in grading should be resolved with the instructor or TA, as appropriate, in the great majority of cases. If the complaint is about the instructor (other than ordinary grading questions) and you do not feel comfortable discussing it with him or her, contact the Director of Undergraduate Studies, Professor Cecile Ane, cecile.ane@wisc.edu. If your complaint concerns sexual harassment, please see campus resources listed at https://compliance.wisc.edu/titleix/resources/. In particular, there are a number of options to speak to someone confidentially. If you have concerns about climate or bias in this class, or if you wish to report an incident of bias or hate that has occurred in class, you may contact the Chair of the Statistics Department Climate and Diversity Committee, Professor Karl Rohe (karl.rohe@wisc.edu). You may also use the University's bias incident reporting system, which you can reach at https://doso.students.wisc.edu/bias-or-hate-reporting/.

Diversity and Inclusion:

Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background - people who as students, faculty, and staff serve Wisconsin and the world.

Accommodations for Students with Disabilities:

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform instructors of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Instructors will work either directly with the student or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA.

Rules, Rights, and Responsibilities

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See: https://guide.wisc.edu/undergraduate/
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Academic Calendar, Elections, and Religious Observances:

Please notify the instructor within the first two weeks of class of which dates you request relief due to a religious observance or election official responsibility.

See: https://secfac.wisc.edu/academic-calendar/#religious-observances

In spring of 2022, there is a primary held on Tuesday, February 15th, and an election on Tuesday, April 5th. I strongly encourage all eligible students to vote.

Designations:

Credits: 3 credits Level: Advanced Breadth: Natural Science L&S credit type: Counts as LAS credit (L&S) Cross listed: M E 424, STAT 424

Requisites

STAT 240, 301, 302, 312, 324, 371, or STAT/MATH 310 Students should have some familiarity with simple linear regression and one-way ANOVA.

Instructional Mode

In-person lecture and discussion sections

Description

Introduction to statistical design and analysis of experiments. Topics include: principles of randomization, blocking and replication, randomized blocking designs, Latin square designs, full factorial and fractional factorial designs and response surface methodology. Substantial focus will be devoted to engineering applications. Enroll Info: None