STAT 158: Design and Analysis of Experiments

"*To consult the statistician after an experiment is finished is often merely to ask him to conduct a post mortem examination. He can perhaps say what the experiment died of*" – R. A Fisher

Lectures: Tuesday, Thursday 2-3:30pm
9 Lewis

Lab: Friday 2-4pm
Friday 4-6pm
332 Evans

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Topics:

- Analysis of variance and hypothesis testing
- Randomization
- Factorial designs
- Fractional Designs
- Blocking
- Repeated Measures / Split-plot designs
- Relation to Linear Regression
- Response surface methodology

Textbook:

Introduction to Design and Analysis of Experiments, G.W. Cobb

A First Course in Design and Analysis of Experiments, G. W. Oehlert (out of print, online)
http://users.stat.umn.edu/~gary/Book.html

Additional readings will be posted on bspace

Prerequisites:

STAT 134 and 135 (or consent of instructor). Statistics 135 may be taken concurrently. Statistics 133 is recommended.

Lab:

Lab time will be spent working on practice problems, how to conduct data analyses in R, and also running experiments.

We assume familiarity with R. If you do not have experience with R, in the first week you should go through online introductions to the programming language (see resources on bspace).

Class Activities and Attendance:

For many designs we will conduct an activity or demonstration in class or lab. These will be used to highlight key concepts in design of experiments and therefore class attendance will be important for full understanding. Past student evaluations have said that attending lecture was critical for doing well in the class, and this is exactly what I expect. To get the full benefit of the class, you should read the material ahead of time, if possible.

I encourage active engagement in the class, and frequently will pose questions and call on people during class. I will also occasionally ask for you to answer questions on an index card in class and turn in the card or otherwise use them during class.

Four experiments will be run in class or section and attendance is **required: Sep. 27th, Nov. 1st, Nov. 22nd, and Dec. 5th**. Results from the experiments may be needed to do homework problems.

Handouts given in class deal with in-class activities and discussions and will generally **not** be posted online, unless they cover material not in the book.

Study Groups:

To aid in learning, I encourage students to sign up for study groups in the second week of class during section. They will consist of 5-6 people from the same section, who are willing to meet at the same time each week for at least 1 hour to review concepts from the class or study for exams; you can also take advantage of any time remaining in section for ad hoc sessions.

I will post suggestions on bspace for how to make the study session effective. I will periodically suggest problems from the book (separate from the HW) or give specific questions or topics that the study sections can discuss and go over. We will not give solutions or grade any of this, though you are welcome to ask questions in office hours.

These are not intended to be sessions where you sit and do homework jointly – everyone should do their homework independently – but you can discuss issues that arise in doing your homework, swap R tips, and help each other in a constructive way. Remember that any increase you get on your homework grade by blindly following others will be drowned out by your inability to do well on the exam on your own!

Course Work:

Homework

Homework will be posted to bspace, and will generally be due two weeks later. All homework is due **in lecture**. There are 6 homework assignments planned. Homeworks will be a combination of computational exercises and data analysis using the computer. Late homeworks will not be accepted except in exceptional circumstances.

The final homework score will be the sum of all homework grades, so 15 points in HW1 counts the same as 15 points in HW5, with points allocated to questions across the semester that aim to be compatible. This means the homework assignment as a block will not count equally, and it is always worth your while to turn in what you have done of your assignment, even if it is incomplete.

Project

There will be a project where you will conduct your own experiments. They will be done in small groups of 3 students, and you will be randomly assigned to a group. The projects will have intermediate steps along the way to help you pace yourself and make sure that your experiment is progressing successfully.

You will be graded on the quality of the writeup as well as the quality of the design and analysis. You will not be graded on the outcome of the experiment. Both projects will count equally.

Each member of the group will also individually evaluate the other members of the group, and the evaluations will not be shared with other members of the group. If there is a problem that appears based on the evaluations, different students within the group may receive different grades, though I

plan that this is the exceptional case. This can be true even if no member of the group "complains" about other students, but merely that I found that the division was inequitable, or that the group did not jointly contribute to the components enough to deserve equal division of the grade (good or bad).

If you feel that there is a problem in your group with regards to how the project is going -- fairly distributing work, etc. -- you may discuss it with me privately so as to find an equitable solution with respect to finishing the project.

Helicopter experiment

A portion of the last homework will be based on an experiment run partially during the class during the last week (the Helicopter experiment). The experiment will be started during the class, but must be finished outside of class and the data will be submitted as part of the last homework, as well as questions to answer about the experiment. You will work in pairs to run the experiment, but you will answer the questions on the HW individually and will be graded separately.

Exams

There will be a midterm (October 17th in class) and a final exam (Dec 17, 8-11am), each of which will count equally.

Overall score

Your letter grade for the course will be based on the total points for all work in the semester.

- Homework (6): 30%
- Project (1): 25%
- Exams (2): 45%

Policies

Late Assignments

Late assignments will not be accepted except with my personal approval, which will be only given for truly extenuating circumstances. I expect any requests to be done as timely as possible.

Email

1) If you wish for your email to make it into my inbox, the subject of your email must contain the text "158"

2) Neither I (nor the GSI) explain course material over email and will not respond to emails with such requests. Please come to office hours, discussion section, or GSI's office hours (or schedule another time to meet if you have irreconcilable conflicts with the office hours).

3) I respond to email regarding the class roughly once a day, and almost never in the evening nor weekend.

Academic Honesty Policy

- Homework must be done independently. If a homework problem is based on an experiment run in class or section, only the experimental results can be done jointly; answering HW questions about the experiment must be done independently. Obtaining and/or using solutions from previous years or from the internet, if such are available, is considered cheating. Within your study sessions, you may discuss issues about the homework, but you must **not** sit down and do the assignment jointly. Please note that while the homework is time-consuming, they are *en masse* 30% of your grade; the cumulative weight is large, but becoming desperate over single questions is **not** worth the risk of cheating!
- For projects students naturally will work with the students in their group, but no other students.

- For exams cheating includes, but is not limited to, bringing written or electronic materials into an exam or quiz, using written or electronic materials during an exam or quiz, copying off another person's exam or quiz, allowing someone to copy off of your exam or quiz, and having someone take an exam or quiz for you.

In fairness to students who put in an honest effort, cheaters will be harshly treated. Any evidence of cheating will result in a score of zero (0) on the **entire** assignment or examination. I will **always** report incidences of cheating to Student Judicial Affairs, which may administer additional punishment.

Disability

If you need accommodations for any physical, psychological, or learning disability, please speak to me after class or during office hours. Please note that if you must make arrangements in a timely manner (through DSP) so that I can make the appropriate accommodations.

Syllabus

The following is only a guide, and there is likely to be slight variation as the semester progresses.

The reading described below is a guide to where the relevant material can be found in the book for the subjects described under 'Topic.' It is not a prescription to when **you** should actually read the material. C=Cobb, O=Oelhart, *=reading not from books, available on bspace

Week	Topics	Class Eventsd	Assigned Reading	Assignments Due
Aug 26	Course Logistics Components of an Experiment	Tea Tasting Anchoring (class)	C: 1.1, 4; O: 1-2.3 NY Times Articles*	
Sep 2	Hypothesis Testing Comparison of two conditions		C: 15 Rice, Ch. 11* O: 2.4	Study groups assigned in section
Sep 9	Single Factor Designs (CR[1])		C: 3, 5; O: 3	
Sep 16	Two Factor Designs (CR[2])		C: 2, 6; O: 8, 9.2	Tu: Hw Due Th: Project Groups Assigned
Sep 23	Checking Assumptions Permutation tests	Rotated J (section: **Sep 27th**)	Cobb: 12 O: 6	
Sep 30	Higher Order Factorials Contrasts and Confidence Intervals		C: 9.1-2, 4-5; C: 11.1-3; O: 4, 9.1	Th: Hw Due
Oct 7	2^k Designs		O: 10.4 Montg. 7.1-4*	Th: Initial Proposal due
Oct 14	Power calculations and simulations	Midterm	O: 7, 10.3	
Oct 21	Block Designs		C: 1.2-3, 7.1, 7.4 O: 13.1-13.2	Th: HW Due
Oct 28	Latin Squares	Needle (section: **Nov. 1st**)	C: 7.2, 7.4, 8 O: 13.3	
Nov 4	Split Plot/ Repeated Measures		C: 7.3-4, 8 O: 16	Th: Design Proposal Due
Nov 11	Random Effects		C: 13 O: 11, 12	Th: HW Due
Nov 18	Fractional Designs	Student Experiments (section: **Nov. 22nd**)	O: 18; Montg. 9.1-9.2*	Th: Protocol Due
Nov 25	Regression	THANKSGIVING	C: 14 O: 17	Tu: HW Due
Dec 2	Response Curve Methodology	Helicopter (class: **Dec. 5th**)	O: 19 Stat Labs, Ch. 12*	Fri: Project writeup due
Dec 9 (RR)				Th: Helicopter HW Due
	Final Exam: Tu, Dec 17, 8-11am			