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 11-12:30pm
166 Barrows

Lab: Wednesday 10-12am, 332 Evans
Wednesday 1-3pm, 340 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). STAT 135 may be taken concurrently. STAT 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.

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.

Three experiments will be run in class or section and attendance is **required: Feb 18th, Mar 11th, and Apr 18th**. Results from the experiments may be needed to do homework problems. The last two weeks of class will involve experiments in class and in section (the 'Hellicopter experiments') which will be needed for doing homework; *attendance is expected*, and more information will be given later in the semester.

Course Components:

Homework

Homework will be posted to bspace, and will generally be due one week later. All homework is due **in lecture**. There are 8 homework assignments planned, though the exact number may change. Homeworks will be a combination of computational exercises and data analysis using the computer.

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. The project 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.

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).

After the first initial proposal is turned in, I will give people the opportunity to switch around in groups if it turns out the group is not working well. After this point, it will be difficult to change group membership. If you feel that there is a problem in your group, 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 two weeks. 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 (March 19th in class) and a final exam (May 14, 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: 30%
- Project: 25%
- Exams: 45%

Policies

Late Assignments

All students will have 5 late days that they may use for turning in homework after the due date. This will take the place of any extensions due to sickness or conflicts, unless there are extenuating circumstances, so use them wisely. To use a late day, you must 1) physically get the HW to the GSI or professor either in their physical possession or with a date stamp (e.g. Statistics front office) AND 2) you must email the GSI to inform him/her that you are using your late days. Late homeworks cannot be received via email, so weekends/holidays will use up late days. Late days cannot be used for the group project.

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 happen to be available, is considered cheating. With other classmates, 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 Experiment	Assigned Reading	Assignments Due
Jan 19	Course Logistics Components of an Experiment	Tea Tasting Experiment *(Fisher's Exact Test)* Anchoring Experiment *(Two-groups)*	C: 1.1, 4; O: 1-2.3 NY Times Articles*	
Jan 26	Hypothesis Testing Comparison of two conditions Permutation tests		O: 2.4 Rice, Ch. 11* C: 15	
Feb 2	Randomized, Balanced Designs (CR[1])		O: 3 C: 3, 5;	Tu: HW Due
Feb 9	Designs with 2 factors (CR[2])	Project Groups Assigned	O: 8 C: 2, 6	Th: Hw Due
Feb 16	Checking Assumptions Higher Order Factorial Designs	Rotated J experiment (in Section: **Feb 18**)	O: 6, 9.2 C: 12; 9.1-5;	Th: Hw Due
Feb 23	Comparisons, Contrasts and Confidence Intervals		O: 4, 9.1 C: 11.1-3;	Th: Initial Proposal due
Mar 2	Block Designs Latin Squares		O: 13.1-13.3 C: 1.2-3, 7.1, 7.4	Th: HW Due
Mar 9	Split Plot Repeated Measures	Needle Experiment (in Section: **Mar 11th**)	O: 16 C: 7.2-4, 8	Th: HW due
Mar 16	Random Effects	Midterm (in class: **Mar 19th**)	O: 11,1-11.3, 12.1-12.6	
Mar 23	SPRING BREAK			
Mar 30	Power		O: 7, 10.3 C: 13	Th: Design Proposal Due
Apr 6	2^k Designs		O: 10.4 Montg. 7.1-4*	Tu: HW due
Apr 13	Fractional Designs	Student Experiments (in Section: **Apr 15**)	O: 18; Montg. 9.1-9.2*	Tu: Protocol Due
Apr 20	Regression and Response Curves	Helicopter I Experiment (in Section)	O: 17 C: 14	Th: HW Due
Apr 27	Running a Response Curve Experiment	Helicopter II Experiment (in class and section)	O: 19 Stat Labs, Ch. 12*	F: Helicopter HW due
May 4 (RR)				Th: Final Project Due
	Final Exam: Th, May 14, 8-11am			