COURSE INFORMATION
Statistics 5303
Spring Semester 2016
4 Credits

Lecture time/place: 12:20–1:10 MWF, 108 Mechanical Engineering, Mpls Campus

Instructor: Gary W. Oehlert

320 Ford
624-8675
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Office Hours: 1:20–2:15 MWF and by appointment.
Scheduled office hours are in my Statistics office in Ford. Other appointments will be in my associate dean office in 115 Johnston. The phone number given above is my Johnston office phone; I don't answer the Ford phone or get its messages.

Texts: Oehlert, G. W. (2000) *A First Course in Design and Analysis of Experiments* (required, available online at no cost)
various R manuals available on line at no cost

Class Web Page: `http://www.stat.umn.edu/~gary/classes/5303`

TA: Christine Storino
350 Ford
stori007@umn.edu
Office hours: Tuesday TBA, Thursday TBA

Recitation: Section 2: 12:20–1:10, Tuesday, Ford Hall 110
Section 3: 1:25–2:15, Tuesday, Ford Hall 110

Course Grade:

Homework	15%
Writing assignments	20%
In-class exams and final	65%

Prerequisites: STAT 5021 or STAT 3022 or equivalent. In reality, the more statistics that you've had the better you'll do and the more you'll get out of the course, although that can probably be said of any statistics course.

Goal and Objectives

Students should become proficient in the statistical design, analysis, and critique of experiments. In particular, students should:

- be able to recognize standard experimental designs from descriptions of how the experiments were run;
- be able to determine the appropriate statistical analysis in standard design situations;
- be able choose appropriate experimental designs for standard experimental situations, based on information about the conditions and goals of the experiment;
- be able to recognize when poor designs or analyses were used;
- be able to diagnose unmet statistical assumptions and, in many cases, be able to make appropriate adjustments;
- be able to communicate the results of an experiment.

This course bears on the following University Student Learning Outcomes for undergraduates:

- Can identify, define, and solve problems.
- Have mastered a body of knowledge and a mode of inquiry.
- Can communicate effectively.

Course Components and Grading

I have included a project in this class for 20 years, but I am going to try something different this year. Communicating what you learn from an experiment is so important that we are going to replace the project with communication assignments. These assignments will take several forms such as a graph, a table, a technical report, and a presentation (e.g., PowerPoint deck). Note that the University Campus Writing Board defines writing as "visual marks conveying meaning." In this sense, these communication assignments are all writing assignments.

The graded components of the course are thus homework, exams, and the communication assignments. Homework problems will be due in lab sections on Tuesdays; a subset will be graded and returned in the following lab. Late homework may not be graded. If you receive more than 80% of the possible points on your homework for the term, you will be given full credit for the homework portion of the course grade. Homework is for learning. Working together on the homework is acceptable, perhaps even encouraged, as it can be a good way to learn the material. However, simply copying someone else's work is never acceptable. Write on your homework telling us with whom you worked (if anyone). It is very difficult to learn the material and pass this course without doing the homework. Most homework problems are old exam questions. Homework solutions will be made available.

Writing assignments will be due in class on certain Fridays. Writing assignments will be graded according to a rubric and returned in lab. Note: writing responses may be shared and discussed/critiqued in lab. Each student will be required to make a brief presentation in lab.

The exams are scheduled for March 9 and May 6; the final exam is May 11 from 1:30–3:30. All three exams will be open book, open notes, and cumulative through the sections described in the week by week part of the syllabus. The first two exams emphasize data analysis with a handful of other questions; some portions of these exams will be take home. The final exam is entirely in-class with no data analysis or take home portion. Exams are for evaluation — you must do your own work on exams. You may use a hand calculator in exams but not your computer. Make up exams can be provided in cases of illness (doctor's note required) and in other cases required by university policy (e.g., religious holidays, certain university activities). Contact the professor *immediately* when such a case arises.

You will note that there is homework due every week, including weeks when we have exams or writing assignments; please plan ahead.

Part of the grade for homework, exams, and especially the writing assignments is for organization and presentation of ideas. A bunch of unannotated computer output will receive little credit. Include only the relevant output and comment about what the output tells you.

I usually grade exam questions on a 10 point scale, with 8–10 roughly corresponding to "A," 6–7, "B," and so on. I grade undergraduates the same as graduates, but convert to letter grades differently. Incompletes (a grade of "I") are given only in extraordinary circumstances (generally medical problems), and then only by written agreement between the instructor and the student. Poor performance in the course is not grounds for an incomplete. Grades of C or better convert to S on the S/N grade basis. If you are making up an incomplete, see me immediately. No "extra credit" work will be accepted.

With the exceptions of the first lecture and exams, attendance is not required.

Disabilities

Students with disabilities that affect their ability to participate fully in class or to meet all course requirements should contact the Disability Resource Center to arrange appropriate accommodation.

Computing

We will be using the **R** program to do our computing. I have used R and its predecessors since the mid-1980s, but I have only used R to teach this course for a few years. I have an R package called `cfcdae` that adds some additional functionality for this class.

Why use R? It is free; it is very high quality; it has a large community; it is used in other statistics classes here. If you wish to use some other program such as SAS, MINITAB, JMP, STATA, etc, that is OK too, but the TA and I will likely not be able to help you if you run into trouble.

The R home page is `http://www.r-project.org`. There you will find links to download the software and documentation.

Lab/discussion/recitation

Sections will be held in Ford 110. Sections will include worked examples, question and answer time, return of homework, instruction in R, discussion of writing, and some student presentation. This room is not a computer lab, but many students find it helpful to follow along as the TA demonstrates analysis, so you might want to bring your laptop if you have one.

UNITE

This course is being taught in a UNITE classroom with lectures captured and made available to students registered (and paying!) through UNITE. However, other students in the class can access the recorded lectures under certain conditions:

> Streaming video archives of class meetings are available to students registered in the on-campus section of this course on a TEN-DAY delay for the length of the semester. This ten-day delay is lifted one week prior scheduled exams as long as students are also enrolled in the course through UNITE Distributed Learning. If there are no UNITE enrollments, the ten-day delay will only be lifted the week prior to finals week.
>
> Access these videos through the UNITE Media Portal with your University of Minnesota Internet I.D. and password (this is what you use to access your University of Minnesota email account).
>
> DO NOT ask the instructor or teaching assistants for technical or troubleshooting assistance with these streaming video archives use the UNITE Troubleshooting FAQ or Submit a Trouble Report to UNITE link found on all pages within the UNITE Media Portal.
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> Technical FAQ: `http://www.unite.umn.edu/streamingvideopodcasts/faq.html`
>
> UNITE Media Portal: `https://www.unite.umn.edu` (note the s in https)

Texts

The text is my own, written specifically for this course although now somewhat out of date. It is out of print, but you can download a pdf of the book from `http://www.stat.umn.edu/~gary/Book.html`. The data sets from the book are also available there. If there is demand we can look into generating hardcopies as well.

Supplements

Supplements (what we used to call handouts, but now offer online and no longer distribute on dead trees) will be available on the class web page, so you should get them there. Supplements are primarily annotated examples and explanations of using R. Copies of the lecture slides are also available there as well. I frequently revise a handout or a lecture just before we use it in class, so while you can get one earlier, be advised that it might change shortly before class.

University Policies

One University policy requires that a lot of other policies be mentioned in syllabi. The following link `www.policy.umn.edu/Policies/Education/Education/SYLLABUSREQUIREMENTS.html` provides links to a list of policies that syllabi are required to reference; these include policies on grading, scholastic dishonesty, makeup work, student conduct, intellectual property, sexual harassment, diversity, disability services, mental health, and academic freedom, among others. You are responsible for understanding the content of these policies.

Homework Assignments

Due	Problems from text
Jan 26	E2.1, E2.5, P3.1 (don't do the analysis, but just explain the trick in this problem, specifically, how many experimental units are there?)
Feb 2	E3.3, P3.2 (report no more than one page), E4.2, E4.4, P4.2
Feb 9	E5.5, P5.1, P5.2
Feb 16	E6.2, E6.4, E6.5, P6.1, E7.2, E7.3, P7.2
Feb 23	E8.1 (you can use the hand formulae, or you can get treatment sums of squares by replacing data by cell means), P8.2, P8.3, P8.7, P8.2
Mar 1	P9.1, P9.2, P9.4
Mar 8	E10.3, E10.4, P10.2, P10.3, P10.6, P10.7
Mar 29	This is a *long* assignment; you have two weeks, but please start early. (It's for your own good, really.) E11.2 (you may interpret "confidence interval" as interval estimate), E11.3, E11.6 (optional but interesting), P11.2, E12.2, E12.3, E12.4 (just draw the frame of the Hasse diagram for E12.2, E12.3, showing nesting/crossing and fixed/random), P12.1 (just do (a) from the standard five questions), P12.3 (just draw the frame of the Hasse diagram), P12.5 (just draw frame of Hasse diagram), P12.8 (you may used another kind of interval estimate in place of a confidence interval if you choose)
Apr 5	P13.1, P13.2, P13.4, P13.6, P13.12
Apr 12	E14.1, P14.4, P14.5, P14.6
Apr 19	E15.2, E15.3, P15.1, P15.4
Apr 26	P16.1, P16.5, P16.8, P16.9, E17.1, P17.1, P17.2(a,b), P17.3(a,b)
May 3	E18.1, E18.2a–e, P18.2, P18.5, P18.6

Writing assignments will be handed out in class, with due dates of Feb 12, Mar 4, Apr 1, and Apr 8.

Date	Topic	Section in Text	General Area
J 19	Lab 1 Introduction to R		
J 20	Introduction	1.1–1.6	
J 22	Randomization	2.1–2.4.1	Randomization
J 25	ANOVA for CRD	2.4.2, 3.1–3.5	Completely Randomized Designs
J 26	Lab 2 Fun with randomization		
J 27	more ANOVA	3.6–3.10	
J 29	Basic contrasts	4.1–4.4	
F 1	Error rates	5.1–5.3	
F 2	Lab 3 More fun with R		
F 3	Pairwise comparisons	5.4–5.7	
F 5	Tables and graphs		
F 8	Violations of assumptions	6.1–6.3	
F 9	Lab 4 Practice residual plots		
F 10	Fixing problems	6.4–6.6	
F 12	Power and sample size	7.1–7.4	
F 15	Factorial treatments	7.5–7.6, 8.1	Factorials
F 16	Lab 5 Discuss graphs		
F 17	Factorial models	8.2–8.6	
F 19	More factorials	8.7–8.11	
F 22	Studying interaction	9.1–9.2.2	
F 23	Lab 6 Practice factorials		
F 24	More interaction	9.2.3–9.2.4	
F 26	Unbalanced data	10.1-10.1.2	
F 29	More unbalanced data	10.1.3–10.3	
M 1	Lab 7 Practice unbalanced factorials		
M 2	Writing reports		
M 4	Two-series factorials	10.4	
M 7	Making presentations		
M 8	Lab 8 Discuss tables		
M 9	First exam, through unbalanced factorials		
M 11	Basic random effects	11.1–11.3	Random Effects
M 21	Variance components	11.4–11.6	
M 22	Lab 9 Practice basic random effects tools		
M 23	Nesting	11.7-11.8, 12.1–12.2	
M 25	Mixed effects	12.3–12.5	
M 28	Hasse diagrams	12.6	
M 29	Lab 10 Practice Hasse diagrams		
M 30	more Hasse diagrams		
A 1	Randomized complete blocks	13.1–13.2	Variance Reduction
A 4	Latin squares	13.3-13.4	
A 5	Lab 11 More Hasse diagrams and report feedback		
A 6	Incomplete blocks	14.1.1	
A 8	More incomplete blocks	14.1.2–14.3	
A 11	Confounding a two-series	15.1.1–15.1.2	
A 12	Lab 12 Practice choosing designs		
A 13	More confounding a two-series	15.1.3–15.1.4	
A 15	Split plots	16.1–16.3	
A 18	Split-split plots and split blocks	16.4–16.5	
A 19	Lab 13 Practice choosing design and presentations		
A 20	Repeated measures	16.6–16.7	
A 22	Covariate models	17.1–17.2	
A 25	General covariate models	17.3	
A 26	Lab 14 Practice choosing design and presentations		
A 27	Fractioning a two-series	18.1–18.3	Treatment Design
A 29	Resolution and projection	18.4–18.6	
M 2	First order response models	19.1–19.4	
M 3	Lab 15 Practice fractions and presentations		
M 4	Second order response models	19.5–19.7	
M 6	Second exam (through response surfaces)		
M 11	Final Exam (comprehensive), 1:30–3:30		