DESIGN OF EXPERIMENTS OBAIS 7045

Wednesday 6:00 – 9:50 PM

2 credit hours

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Office Hours: 4:30 – 5:30 PM Wednesday and by appointment.

Office hours provide you with an opportunity for personal discussion with me concerning course-related problems such as homework, clarification of classroom discussion, text interpretation, test grading, etc. If the formal hours are unsuitable for you, please make an appointment with me at a mutually agreeable time. I strongly urge you to take advantage of these hours.

Tests: Homework assignments due in weeks 4 and 7will be collected in lieu of in-class mid-term exams. These assignments will stress concepts and calculation methods. The comprehensive final project will have the character of a data analysis *project* in which you will be expected to comprehend experimental design concepts and exercise computational skills. These projects will be discussed on the last day of class. A written report on the project will be due on the day indicated on the university schedule. No one is exempt from either exam. If you cannot take the midterm at the time indicated or will not be available to discuss the final project due to a reason beyond your control, you must inform me in advance so that we may make an alternative arrangement. Failure to due so will result in a grade of zero for that exam.

Homework: Assignments of problems will be given in class or posted on Blackboard. Solving these problems is important for reinforcing your comprehension of the material and in honing your computational skill with the chosen software. If you do them faithfully, I guarantee that you will have an easier time with the exams/projects than otherwise. You are welcome to discuss the solution of your problems with me during office hours. But, I strongly urge you to collaborate with your colleagues in a responsible manner in attempting these problems, i.e., each party contributing equally to any cooperative arrangement.

Grading: Midterm 1 = 20%
Midterm 2 = 30%
Final Project = 40%

The remaining 10% will be based on any assignments I may collect and on 'intangible' sources that may reflect 'attitude' such as participation in class discussion, and helping with the SAS implementation of the computations.

The grade of Incomplete will be given only for fully documented medical conditions or other catastrophes as judged by me. You may drop the course without penalty up to the date set by UC for such eventualities).

No special exams/projects, or assignments will be given at quarter's end for grade improvement. Students are responsible for all material, assignments and announcements made in class. All exams/projects will be carried out as described in the section on group work activity (below). The final exam/project will remain in my possession for two quarters. You should retain all other assignments or graded material throughout this course.

Group Work Structure of the Course: After the first class, each student may join a work group. A work group will consist of two students. This work group will be maintained for the length of the quarter. The work group will cooperate in all work given during the quarter including practice problems, studying, and projects (midterm and final projects). All members of a group will share grades on any submitted work. All members are to contribute equitably to the shared workload, carrying a fair weight for the burden. Group-work is not an invitation to slouch! At the end of the quarter, members of each group will be asked to evaluate the contribution of the other work group peers on the basis of a number of criteria taking into consideration such factors as intellectual contribution, attendance at group meetings, mentoring and sharing knowledge, writing up the results, and running relevant SAS codes. The peer score will reflect, in some sense, an average over all of the work assigned as well as an average of the criterion above. Thus, a student in a work group who may have contributed much on one assignment, may not

have contributed the majority of the work on another, yet still such work may be considered by other members to be meritorious "on the average". This evaluation will be confidentially submitted to me. A copy of the evaluation form is in the Blackboard site under FINAL EXAM.

Academic Integrity: As with all Lindner College of Business efforts, this course will uphold the highest ethical standards, critical to building character (the C in PACE). Ensuing your integrity is vital and your responsibility. LCB instructors are required to report ANY incident of academic misconduct (e.g., cheating, plagiarism) to the college review process, which could result in severe consequences, including potential dismissal from the college. For further information on Academic Misconduct or related university policies and procedures, please see the UC Code of Conduct (http://www.uc.edu/ucinfo/conduct.html). I subscribe to the UC policy on academic integrity and I will take appropriate action if I discover plagiarism or any student disregarding instructions on the limitations I place on consultation regarding exams/projects. Please be aware of this code and abide by its provisions.

In particular, do not consult any source or person outside of your own workgroup when producing exam/project material that you intend to submit for a grade. If a notice of cancellation appears on the classroom door, or if you hear of such a cancellation, you must remain in the classroom for a period of ten minutes to confirm this action. I regard a student's attitude and interest to be a very important component in evaluation and I reserve the right to raise a grade based on my impression. You are strongly urged to suggest any improvements in the teaching or classroom procedure.

Excused Absence Policy: I do not take attendance. While I do appreciate your courtesy in informing me of an absence, or if you must come to class late or leave early, it is not necessary to inform me. The faculty senate has issued a statement of policy regarding make-up work for days missed due to religious observance. It reads in part, "Any UC student who is unable to attend classes or participate in any examination, study or work requirement on some particular day(s) because of his or her religious belief should be given the opportunity either to make up the work that was missed or to do alternative work that is intrinsically no more difficult than the original exam or assignment — provided that the makeup work does not create an unreasonable burden upon University of Cincinnati and its faculty. Upon request and timely notice, students should be provided reasonable accommodation." My personal policy is that if you need to miss a class or part of a class for religious reasons or any other reasons for that matter, it is acceptable to me. Take what you want from this experience. Since exams/projects may be take-home affairs, the issue of excused absences is nullified anyway, and so I expect that all due dates will be honored. In addition, the information technology people tell me that they will record each class and make them available to you, so that a missed class can be reasonably recouped with some effort on your part. As stated elsewhere in this syllabus, every student is responsible for whatever takes place in the classroom. Missed study opportunity is an issue that you can take up with the members of your work-group; it does not concern me. As stated elsewhere in this syllabus, you will have the opportunity to rate your team members' participation and performance at the end of the term. I will not offer any student any alternative work or make-up assignments.

Course Materials: I have not made a text book a required purchase by you for this course. But having access to certain references materials will be a very great boon indeed. Below I am listing the texts that are great resources. I will be using problems from the Montgomery text on my assignments (as well as others). Thus, having someone in you group with one or more of the texts listed below will be good for all of you. Perhaps members in a group can share the expense, and only purchase one new or used copy of a reference for the whole group. It is completely up to you how you want to work this out. The Montgomery text is available at the UC bookstore.

Every student will obtain a ***Blackboard*** account by going to http://blackboard.uc.edu/ on the INTERNET. We will use Blackboard to communicate. Class notes and assignments will be available on this site as well as all of the class notes and all of the SAS programs used in class are there and more. Please explore this site.

Texts and References:

1. **Design and Analysis of Experiments**, Douglas C. Montgomery, 8th Ed. (Older editions are OK too)
2. **Analysis of Messy Data**, Milliken and Johnson, Vol. 1, 2nd Edition – This is an excellent reference. Many of my notes come from this book.

3. **SAS for Linear Models**, Littell, Stroup, Freund, 4th Ed. – I find this book to be the most helpful SAS reference for using PROC GLM and other procedures we will use. I strongly urge you to somehow find access to this one.
4. **SAS Systems for Mixed Models**, Littell, et al, 2nd Ed – Another useful but less vital reference.
5. **SAS manuals** (see below).

Additional Documentation and Other Resources:
We will be analyzing the data provided in the text problems and other problems. It is convenient to use a computer to aid in these analyses. Therefore you may wish to use SAS. There are several PC's in computer labs and in the main CoB computer lab with these same SAS procedures available using PC SAS. Computer labs all around campus in, e.g., Engineering, Education, etc. also have SAS installed. Using these machines carries the disadvantage of requiring your presence on campus. I will provide you with many 'recipes' for implementing the analyses, but for the most part, you will be able to refer to the SAS manual mentioned below for guidance. Note that you do not have to buy any SAS manuals. All of them are available on ***SAS ONLINE Version 9.1 or 9.2:*** the URL to visit is http://support.sas.com/onlinedoc/913/docMainpage.jsp . Documentation may also be found at: http://support.sas.com/cdlsearch?ct=80000 or http://support.sas.com/documentation/cdl/en/allprodsproc/61917/HTML/default/a003135046.htm#a003145693.

All computer system inquiries may be addressed to the CoB computer consultants who should be well equipped in this regard. Two useful resources are the SAS Statistics manual and the **SAS/IML Guide** (all available on-line). The IML guide provides details on a very powerful matrix-based language with which programs for analyzing data from many designed experiments can be written. **SAS/STAT**, the SAS statistics manual contains documentation for the procedures such as PROC GLM and PROC MIXED that we will be using extensively. You may or may not find paper copies of some of these SAS manuals in the computer consultants' office in the CoB or in other computer facilities around campus. But as I mentioned, the Blackboard site has all of the manuals you will need in .pdf format. Please to not try to print out the manuals. There are thousands of pages. While it is not necessary, some of may wish to purchase your own copy, if you will use this stuff as a professional or advanced graduate student.

A very convenient and free way to access SAS is through the UCvlabs virtual computing environment. Instructions on installation of the VMWare View Client to connect to UCvlabs is included on the *Blackboard* site.

A third alternative is to buy a license for SAS form UCIT. I do not know the price, but I think it is $100.00 (take your complaints to them). A few students in each class I teach with SAS do obtain the license. I will supply all SAS recipes using SAS command line format. These can all be run under Enterprise Guide.

Course Description: This course assumes knowledge of statistical methods and applied regression at the level of the courses taught in the CoB (OBAIS 721 and 722). The 721 courses provide a survey of statistical methodologies useful for research in a variety of disciplines which make use of data collected in experiments or observational studies. The 722 course is a survey of methods of applied regression. While not absolutely essential, the knowledge from these topics will prove to be very helpful. If you did not take these courses, then I can simply say that there is no substitute for hard work and diligence. The use of SAS for implementing data analyses on the computer is an important feature of the course as well. Both of these courses used SAS.

Student Learning Outcomes: The goals of this course are to introduce the students to the terminology, use and some underlying statistical principles of experimental design with particular emphasis on the correct analysis of data arising from designed experiments. We will discuss several experimental designs, their advantages and disadvantages, estimation of treatment effects, and significance testing. Computer examples and assignments using SAS procedures will complement the lectures. We will emphasize the data analytic and statistical aspects of the design of experiments in this course rather than the philosophy of science. The topics covered should be useful to students at the Masters and Ph.D. level who might be involved in the design of experiments or the collection, analysis and interpretation of data from designed experiments. This includes student in business, economics, the life and health sciences, engineering, social sciences, mathematics, and statistics. A good statistical methods course is a prerequisite and a course in applied regression is very strongly recommended as a prerequisite

Course Syllabus:

A. Topics to be covered:

Introduction
Comparing several treatments-one factor experiments
Completely randomized design
Analysis of fixed effects model
Matrix approach to the analysis
Analysis of heteroscedastic data
Simultaneous inferences and multiple comparisons
*Trend analysis using orthogonal polynomials (intro. to response surface methods)
Analysis of random effects model
Selecting the sample size
Analysis of covariance - one factor treatment structure in a completely randomized design
Factorial experiments
Two factor experiment in a completely randomized design
Meaning and importance of interaction
Meaning and importance of estimability
Meaningful contrasts
*Using orthogonal polynomials to detect trends
Three factor experiments- fixed, mixed, and random effects
Importance of the expected mean square
'Manufactured' F-tests
Randomized block and related designs
Randomized complete block experiment
Latin square design
Efficiency of blocked designs
Analysis of contrasts in blocked designs
Incomplete block designs
*Least squares means explained
Nested designs
Split plot designs
Split-split plot designs
Repeated measures designs

* Possibly covered in class or only in notes, depending on time.

Other possible topics we may cover are: 2^k factorial arrangements in completely randomized designs (CRDs) and blocked designs, generating and analyzing data from other fractional factorial arrangements in CRDs and blocked designs, Resolution III, IV, V, and related designs, Plackett-Burman designs

B. Course Schedule

Week	Topics to be covered
January 11	Introduction, orthogonality, homoscedasticity, comparing treatment means
January 18	Multiple comparisons, sample size
January 25	Modeling, ANCOVA
February 1	factorial experiments
February 8	Random effects, mixed models
February 15	Randomized block and incomplete block designs
February 22	Hierarchical designs, split-plot designs
March 1	Repeated measures, discuss projects

B. Approximate Correspondence Between Syllabus and Text The material to be covered in class corresponds very roughly to the following pages in the Montgomery text. In addition, material in the notes will be covered which has no direct correspondence with pages in the text. This latter material has been synthesized by the instructor from various sources including, the primary reference text, **Analysis of Messy Data**, Milliken and Johnson, Vol. 1, 2nd Ed., SAS manuals, and his own notes. The first two chapters will not be covered but chapter 1 is recommended reading, while the material in chapter 2 is prerequisite, and should have been covered in your statistical methods course (a firm prerequisite for entry into this course). The order of the lectures will not correspond to the order of the chapters in the text. For example, the material on blocked experiments will follow material on factorial designs. This correspondence does not take into account the possible topics listed above.

CHAPTER	PAGES
1(Reading only)	1-22
2(Prerequisite stuff)	25-59
3	65-138 the supplemental stuff is recommended. Some is in my notes.
4	139-182 "efficiency" in supplement is recommended…in notes too.
5	183-232 leaving out section 5-5
13	573-603
14	604-641
15	642-682