MATH 744/844 Summer 2020
Design of Experiments II

Section 1ON: Online Only, no live scheduled sessions.

CRN: 744 (undergraduate) is 71001, 844 (graduate) is 71002
Schedule: 5/18/2020 to 7/24/2020
Instructor: Philip J. Ramsey, Ph.D.
Office Hours: Arranged online only via Zoom.
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Course Overview

This class is an online only course with no regularly scheduled class meetings. All content is delivered through organized modules on myCourses (Canvas) and modules are typically assigned on a weekly basis. Students will be asked to watch assigned videos (primarily instructor videos), do assigned readings (mostly instructor notes) complete homework assignments, and quizzes. Lectures are delivered using pre-recorded videos and links to the appropriate videos will be posted within each course learning module. All class notes, assignments, and materials will be posted on myCourses.

Description

Second course in design of experiments, with applications in quality improvement and industrial manufacturing, engineering research and development, research in physical and biological sciences including agriculture and animal science. Covers experimental design strategies and issues that are often encountered in practice: complete and incomplete blocking; partially balanced incomplete blocking (PBIB); partial and complete aliasing; split plot and strip plot design structures; repeated measures; crossover designs; Latin squares and rectangles; Youden squares; crossed and nested treatment structures; variance components and mixed effects models; analysis of covariance; optimization; space filling designs; modern optimal design strategies; functional data analysis (when the response is a curve). Prereq: MATH740; **or permission**.

Math 740/840 Materials

As a reference I have a YouTube channel with 40 videos that I created that cover the material in Design I. The channel is public and and you can go there to watch videos and review videos covering Design I topics. The link to the channel is https://www.youtube.com/channel/UCp8OlkIlxt6NOs9GAgh1zTQ.

Attendance Policy

Students are expected to complete all assigned work in a timely manner and turn in assignments on time. Given this is a Summer course students must keep current with the learning modules and assignments.

Textbook

One book is for required for the class and readings will be assigned from it and in some cases students may be required to discuss the readings (details will be posted on myCourses). The book "Optimal Design of Experiments: A Case Study Approach", by Goos and Jones (2011) is widely available through book sellers or **a free e-book is available through the UNH library**:

Here is a link to the free ebook version https://ebookcentral.proquest.com/lib/unh/detail.action?docID=697607 . You will be prompted for your username and password.

Software

The JMP Pro 15 statistical software is fully integrated into the course and students will need the software to complete many assignments. The software is available as a free download for UNH students and faculty. Please go to the following link and follow the directions to download and install JMP; https://td.unh.edu/TDClient/KB/ArticleDet?ID=770 ; the link may list JMP 14.2, however if you click on the link it will take you to a Box site where JMP Pro 15.0 is available.

Short Quizzes

Occasionally short, online quizzes may be posted on myCourses and students will typically have a 48 hour window in which to complete the quiz. These are given to encourage students to stay engaged in the course. The **quizzes if assigned are to be done individually** and students **are not to collaborate** in completing them. The number of quizzes is to be determined during the summer term.

Homework

Homework assignments will be given and graded to reinforce the concepts presented in the reading and in the class discussion.

Statistical Thinking for Industrial Problem Solving (STIPS)

STIPS is a new free, online course in statistics with a focus on industry that has been created by the SAS Institute (JMP is a division of SAS). Your instructor was very much involved in the design and the content of the course. You can learn about the course and watch an introductory video at the link https://www.jmp.com/en_us/statistical-thinking.html. Some of the modules in the STIPS course will be assigned as a part of this course. More details on STIPS will be provided when modules are assigned. Remember the course is free and is quite comprehensive; we will cover only a small portion of the content. For those who might be interested, if you complete all of the STIPS modules it is possible to become certified. The course also has a JMP Learning Lab where you can gain

more experience in how to use JMP for analyses. You may use your own copy of JMP (preferred) doing the course or a server version is available through the course site.

Submitting Homework and Project Reports

Your solutions for the homework and projects are to be submitted electronically via myCourses; simply upload your completed assignment through the original assignment posted on myCourses. Electronic submittals for regular homework **must be in PDF format.** Uploading the homework and project solutions through myCourses is important for grading purposes. Note, handwritten assignments are no longer accepted.

Final Project

Due to the anticipated limited interaction possible among students during the Summer session 2020, an **individual final project will be assigned**. The projects usually consist of an originally designed experiment by the student that they perform, analyze, conclusions reached, and submit a final report written. However, for the summer 2020 all students will be given the same project with the same details and the project will be performed on a simulator rather than performing a physical experiment.

Grading Scheme

Item	**% of Grade**	**Requirements**
Quizzes	**20%**	Number of quizzes will be determined during the semester
Homework	**55%**	Your solutions for the homework are to be submitted electronically via myCourses. The submitted assignment must be in PDF format. To submit the homework via myCourses, go to the original assignment to open it, and you will see an option to upload files.
Final Project	**25%**	Design, run, and correctly analyze an experiment. Details to be provided during the semester.

Potential Course Topics (the actual content may vary with student interests)

1. General Incomplete Blocking Designs (Balanced Incomplete Blocks);
2. Partially Balanced Incomplete Blocking (PBIB);
3. Confounding and Partial Confounding; Intra and Inter Block information in General Incomplete Block designs;
4. Split Plot and Strip Plot design structures where randomization is restricted;
5. Repeated Measures on experimental units over time or space;
6. Crossover Design Strategies;
7. Latin Squares and Rectangles, Youden Squares;

8. Plackett Burman Designs, Definitive Screening Designs, Supersaturated Designs;
9. Optimal Design strategies and criteria;
10. Robust Product Designs and Taguchi Designs;
11. Space filling designs and Gaussian Process Modeling for experimentation via simulation programs;
12. Crossed and Nested Treatment Structures and/or Design Structures;
13. Mixture Process factor designs;
14. Analysis of Covariance;
15. Optimization Strategies with Multiple Responses.
16. Functional Data Analysis

Course Schedule (This is a preliminary schedule for planning purposes only, actual coverage and assignments may vary during the semester)

Week	*Date*	*Topics Covered*	*Assignments and Due Dates*
One	May 18 – May 25	Review of Design of Experiments concepts and use of the JMP Software. Review Basic Statistical Inference.	• Watch assigned videos on DOE introduction to JMP • Do assigned readings in notes. • **Complete STIPS Module 6 quiz and upload Badge to Canvas as proof of completion**. • **STIPS Module 4**.
Two	May 25 – June 01	Complete Blocks, Latin Squares, Graeco Latin Squares. Review ANOVA, Multiple Comparisons	• Watch assigned videos for this topic • Do assigned readings • Review ANOVA and Multiple Comparisons (Math 740). • **STIPS Module 4** • Homework Assignment #1
Three	June 01 – June 08	Hierarchical Design Structure and Hierarchical and Crossed Structures, Random Effects, Mixed Models	• Watch assigned videos for this topic • Do assigned readings • **Quiz** Multiple Comparisons
Four	June 08 – June 15	Analysis of Covariance, design structures with nominal and continuous factors. Review Regression Modeling	• Watch assigned videos on the topic • Do assigned readings in notes • Goos and Jones Chp. 2 (review for background), 9. • Review Regression **STIPS Module 5**. • Homework Assignment #2
Five	June 15 – June 22	Incomplete Blocking structures, general, balanced, partially balanced, and incomplete blocking of factorial treatments. Youden Squares.	• Watch Assigned videos for this topic • Review Fractional Factorials (Math 740) • Review incomplete blocking of factorial treatments (Math 740) • Do assigned readings in notes. • Goos and Jones Chps 7, 8. • Homework Assignment #3
Six	June 22 – June 29	Split Plot and Strip Plot design structures. Crossover Design structures and analysis issues.	• Watch Assigned videos for this topic • Do assigned readings of notes • Read Goos and Jones Chps. 10, 11 • Homework Assignment #4

Seven, Eight	June 29 – July 13	Modern Optimal Designs and Theory. Model Selection Strategies. RSM Designs. Definitive Screening Designs. FWB and Model Averaging.	• Watch Assigned videos for this topic • Do assigned readings • Review model selection notes (Math 740) • Review RSM Designs and Definitive Screening Designs (Math 740) • Goos & Jones Chp. 2 (read in-depth) and 4. • **Quiz** on screening design topics • Homework Assignment #5
Nine	July 13 – July 20	Space Filling Designs and Gaussian Process Models. Dealing with Multiple Responses and simulation strategies for optimization.	• Watch Assigned videos for this topic • Do assigned readings • Goos and Jones Chp. 5. • Homework Assignment #6 • Final Project Assigned
Ten - End of Semester	July 20 – July 24	Repeated Measures and Functional Data Analysis	• Watch Assigned videos for this topic • Do assigned readings • Final Project Due

University Disability Accommodations

The University is committed to providing students with documented disabilities equal access to all university programs and facilities. If you think you have a disability requiring accommodations, you must register with Disability Services for Students (DSS). Contact DSS at (603) 862-2607 or disability.office@unh.edu. If you have received Accommodation Letters for this course from DSS, please provide me with that information privately in my office so that we can review those accommodations. Of course, you should always feel free to discuss any disability issues with me and all such conversations are kept in strict confidence.

Emotional or Mental Health Distress:

Your academic success in this course is very important to me. If, during the semester, you find emotional or mental health issues are affecting that success, please contact the University's Counseling Center (3rd fl, Smith Hall; 603 862-2090/TTY: 7-1-1), which provides counseling appointments and other mental health services .

Academic Honesty and Plagiarism

Students are required to abide by the UNH Academic Honesty as described in the student handbook. Students are expected to submit their own original work and further guidelines will be issued with specific assignments during the semester; plagiarism will not be tolerated, especially copying homework from one another and cheating on quizzes. The rules will be enforced. Here is an important link on academic honesty **https://www.unh.edu/student-life/09-academic-honesty**