Department of Mathematics & Statistics
Concordia University

STAT 468 (MAST 679/881), Sec. D

Design of Experiments

Fall 2018

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Office Hours: Wednesdays, 16:00-17:30.

Prerequisite: STAT 360 previously or concurrently.

Text: *Design and Analysis of Experiments*, 9th Edition, by Douglas C. Montgomery (John Wiley, 2017).

Reference: *Linear Models* by S.R. Searle (John Wiley, 1971).

Objective: Design of experiments deals with efficient allocation of 'treatments' to experimental units so as to reduce experimental error variability in the response of interest and to provide valid, efficient, repeatable inference about the former. This course is an introduction to the basic principles, constructions and analysis of the commonly used, linear model-based, experimental designs. We shall first review the distributions and commonly used statistical test procedures for drawing statistical inference as well as model-validation of the standard designs. There will be theoretical as well as numerical problems in the assignments and exams. *Graduate students will be assigned additional reading material, assignment as well as exam problems*.

Final Grade:

a) Assignments (5 *approx.*)	20%
b) Mid-term (***19 October 2018***)	30%
c) Final	50%

If the grading scheme for this course includes graded assignments, a reasonable and representative subset of each assignment may be graded. Students will not be told in advance which subset of the assigned problems will be marked and should therefore attempt all assigned problems.

IMPORTANT: **PLEASE NOTE THAT THERE IS NO "100% FINAL EXAM" OPTION IN THIS COURSE.**

Topics: *Selected sections from the following chapters*: Introduction to designed Experiments (Ch. 1); Simple comparative experiments (Ch. 2); Experiments with a single factor: the analysis of variance (Ch.3); Randomized blocks, Latin Squares and related designs (Ch.4); Introduction to factorial designs (Ch.5); The 2^k factorial design (Ch.6); Blocking and confounding in the 2^k factorial design (Ch.7); Two-level fractional factorial designs, (Ch. 8); Other topics on factorial and fractional factorial designs (Ch. 9); Response surface methods and designs (Ch.11); Random effects models (Ch. 13); Experiments with nested factors and hard-to-change factors (Ch. 14)

Week	Topics
1	**1 Introduction to Designed Experiments** Strategy of Experimentation, Some Typical Applications of Experimental Design, Basic Principles, Guidelines for Designing Experiments **2. Simple Comparative Experiments:** Basic Statistical Concepts, Sampling and Sampling Distributions, Inferences About the Differences in Means- Randomized Designs
	Hypothesis Testing, Confidence Intervals, Choice of Sample Size, Inferences About the Differences in Means, Paired Comparison Designs, Inferences About the Variances of Normal Distributions.
2	**3 Experiments with a single factor: Analysis of Variance** An Example, The Analysis of Variance, Analysis of the Fixed Effects Model, Model Adequacy Checking.
	Practical Interpretation of Results. Determining Sample Size
3	**The Random Effects Model:** A Single Random Factor, Analysis of Variance for the Random Model, Estimating the Model Parameters.
	The Regression Approach to the Analysis of Variance, Least Squares Estimation of the Model Parameters, The General Regression Significance Test.

4	**4 Experiments with Blocking Factors** The Randomized Complete Block Design, Statistical Analysis of the RCBD, Estimating Model Parameters and the General Regression Significance Test
	The Latin Square Design, The Graeco-Latin Square Design,
5	Balanced Incomplete Block Designs, Statistical Analysis of the BIBD
	Least Squares Estimation of the Parameters, incidence matrix and constructions (selected)
6	**5 Factorial Experiments** Basic Definitions and Principles, The Two-Factor Factorial Design , Statistical Analysis of the Fixed Effects Model
	One Observation per Cell, The General Factorial Design, Blocking in a Factorial Design
7	**6 Two-Level Factorial Designs** The 2^2 Design, The 2^3 Design, A Single Replicate of the 2^k Design
	Mid-term exam, 19 October (Covering Chapters 2-5)
8	**7 Blocking and Confounding Systems for Two-Level Factorials** Blocking a Replicated 2^k Factorial Design, confounding in the 2^k Factorial Design
	Confounding the 2^k Factorial Design in Two Blocks; Partial Confounding
9	**8 Two-Level Fractional Factorial Designs** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design
	9 Other Topics on Factorial and Fractional Factorial Designs The 3^k Factorial Design: The 3^2 Design, The 3^3 Design

10	Confounding in the 3^k Factorial Design in Three Blocks
	11 Response Surface Methodology Introduction to Response Surface Methodology, The Method of Steepest Ascent
11	Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces
	Designs for Fitting the First-Order Model, Designs for Fitting the Second-Order Model, Mixture Experiments.
12	**13 Random Effects Models** Random Effects Models, The Two-Factor Factorial with Random Factors
	The Two-Factor Mixed Model, Approximate F Tests
13	**14 Experiments with Nested Factors and Hard-to-Change Factors** The Split-Plot Design, The Split-Split-Plot Design (concept)
	Review

Academic Integrity and the Academic Code of Conduct

This course is governed by Concordia University's policies on Academic Integrity and the Academic Code of Conduct as set forth in the Undergraduate Calendar and the Graduate Calendar. Students are expected to familiarize themselves with these policies and conduct themselves accordingly. "Concordia University has several resources available to students to better understand and uphold academic integrity. Concordia's website on academic integrity can be found at the following address, which also includes links to each Faculty and the School of Graduate Studies: concordia.ca/students/academic-integrity." *[Undergraduate Calendar, Sec 17.10.2]*