King Fahd University of Petroleum and Minerals
Department of Mathematics
STAT-530: **Design and analysis of experiments (**Term 242)

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STAT 530: Design and Analysis of Experiments (3-0-3)
Completely randomized design. Randomized block design. Latin square designs. Models: Fixed, random, and mixed models. Incomplete block design. Factorial experiments 2k designs. Confounding in 2k designs. Nested and Split-plot designs. Fractional and orthogonal designs. Fractional replicate and orthogonal designs. Using statistical packages (e.g. Statistica, Minitab, SAS, SPSS, etc.) to analyze real data sets.
Prerequisites: Graduate Standing. Cannot be taken for credit with STAT 511 or ISE 535.

Course Objectives: STAT530 is intended to be a foundation course in design and analysis of experiments. The emphasis is on understanding how to experimental designs to solve real-world problems. Upon completion of this course, students should be able to:

- understand the least square method with reference to experimental designs
- analyse the simple and factorial experimental designs with ANOVA
- validate the assumptions of design models through residual analysis
- develop the hypothesis for design models
- handle different experimental designs and their analysis
- comprehend the assumptions, methods, and implications associated with various experimental methods
- emphasise on the role of factorial experiments in DOE
- discuss the special type of 2^k factorial designs in DOE
- highlight the role of confounding in design of experiments
- implement analysis procedures on real datasets using R packages

Textbook: Montgomery, D.C. (2019). Design and Analysis of Experiments. 10th edition, Wiley, New York.
Software Packages: R Language + RStudio
Reference Book: Lawson, J. (2015). *Design and Analysis of Experiments with R*. CRC press.

Assessment

Activity	Weight
Classwork (quizzes, assignments, attendance, etc.)	10%
Midterm Exam(s)	30%
Project	30%
Final Exam (Comprehensive)	30%

Letter Grades: The letter grades will follow a relative grading scheme, which depends on the average of all students enrolled in the course.

R Language and RStudio: All R commands, procedures and packages will be explained in the class and the student are expected to practice them during and after the class.

Project Description
The project should be based on a real problem (with complete description) and a detailed analysis using the skills developed in the course. All results of the project should be made available numerically with the software/packages used in class. There should be some concluding remarks that refer to the real implications of your chosen problem. You may use online sources in your project with proper citation/reference.
Project Requirements:

- Each group should contain 3 students.
- Each group should submit the following:
  - a formal report (pdf)
  - a power point presentation
- Deadline: The end of semester (before the last day of classes)

Weekly Schedule

Week	*Topics*	*Book Chapter*
Week 1	**An introductory review** • A review of basic terminologies • A review of fundamental statistical procedures • Introductory session using R and RStudio (libraries and packages in RStudio) • Exporting Excel and text files to RStudio	Chapters 1&2
Week 2	**Introduction to design of experiments** • Defining experimental design • Basic principles of experimental designs • Introducing basic designs	Chapters 1&2
Week 3	**ANOVA models for experimental designs** • One way ANOVA model and its analysis • Two way ANOVA model and its analysis • Implementation of one and two way ANOVA models using RStudio	Chapter 3
Week 4	**ANOVA models for experimental designs** • extended ANOVA models and their analysis • Implementation of extended ANOVA models using RStudio	Chapter 3
Week 5	**Block Designs** • Randomized complete block design and its analysis using two way ANOVA model • Latin square design and its analysis using three way ANOVA model • Graeco Latin square design and its analysis using four way ANOVA model • Implementation of design models using RStudio	Chapter 4
Week 6	**Residual Analysis and Non-Parametric methods** • Testing model assumptions using residual analysis • Uisng non-parametric techniques for analysis of DOE • Graeco Latin square design and its analysis using four way ANOVA model Implementation of design models using RStudio	Chapters 3&4
Week 7	**Factorial Designs** • Multi factor experiments and their graphical analysis • Conducting factorial experiments using **basic** designs • Implementation of factorial designs using RStudio	Chapter 5
Week 8	**Factorial Designs** • Multi factor experiments and their graphical analysis • Conducting factorial experiments using **extended** designs • Implementation of factorial designs using RStudio	Chapter 5
Week 9	**2^k factorial designs** • Level 2 factorial designs • Sign table, Yate's algorithm, modulu 2 method for linear contrasts • Implementation of 2^k designs using RStudio	Chapter 6
Week 10	**Confounded Designs** • Handling confounded designs and their analysis • Implementation of 2^k designs using RStudio	Chapter 7
Week 11	**Fractional Designs** • Theory of fractional designs and their analysis • Implementation of 2^k designs using RStudio	Chapter 8
Week 12	**Additional Designs in Factorial & Fractional Factorial** • Dealing with factorial and fractional designs and their analysis • Implementation of 2^k designs using RStudio	Chapter 9
Week 13	**Nested Designs** • Execution of nested designs and their analysis • Implementation of 2^k designs using RStudio	Chapter 14
Week 14	**Split Plot Designs** • Using nested designs in DOE and their analysis • Implementation of 2^k designs using RStudio	Chapter 14
Week 15	**Analysis of covariance using ANCOVA models** • Role of covariates in DOE • ANCOVA models and their analysis • Implementation of ANCOVA using RStudio	Chapter 15
Week 16	**Some advanced selective topics in experimental designs**	

Important Notes:

Blackboard: All contacts or announcements between the instructor and the students are supposed to be through Blackboard, so the student must check Blackboard at least once a day.

Academic Integrity: All KFUPM policies regarding ethics and academic honesty apply to this course.

Important Rules

1- Student is not allowed to enter the exam hall without either KFUPM ID cards or Saudi ID/ Iqama ID cards.
2- Students are not allowed to carry mobile phones and smart watches to the exam halls.
3- Students need to strictly adhere to the attendance policy of the university.
4- DN-Grade will be assigned to the eligible students after their instructors have warned them twice.

Cheating in Exams

Cheating or any attempt of cheating by use of illegal activities, techniques and forms of fraud will result in a grade of **DN** in the course along with reporting the incident to the higher university administration for further action. Cheating in exams includes (but is not restricted to):

➢ looking at the papers of other students

➢ talking to other students

➢ using mobiles or any other electronic devices.

Missing an Exam

In case a student misses an exam for a legitimate reason (such as medical emergencies), he/she must bring an official excuse from Students Affairs. Otherwise, he/she will get zero in the missed exam.

Attendance

- Students are expected to attend all lecture classes.
- If a student misses a class, he is responsible for any announcement made in that class.
- Attendance on time is very important. Mostly, attendance will be checked within the first five minutes of the class. Entering the class after that, is considered as one late, and every two times late equals to one absence.
- A DN grade will be awarded to any student who accumulates more than 20% unexcused absences or 33.3% excused and unexcused absences.

The usage of mobile phones and apple watches

- Students are not allowed to use mobiles for any purpose during class time unless given permission.
- Violations of these rules will result in a penalty decided by the instructor.
- Academic Integrity: All KFUPM policies regarding ethics apply to this course. See the Undergraduate Bulletin.