King Fahd University of Petroleum and Minerals
Department of Mathematics
STAT-511: **APPLIED REGRESSION AND EXPERIMENTAL DESIGN (**Term 241)

Instructor: Dr. Muhammad Riaz
Office: 5-332
Phone: 013-860-7622
E-mail: riazm@kfupm.edu.sa
Office Hours: will be announced later

STAT 511: Applied Regression and Experimental Design (3-0-3)

Simple linear regression. Estimating and testing of intercept and slope. Multiple linear regressions. Estimation parameters and testing of regression coefficients. Prediction and correlation analysis. Analysis of variance technique. Completely randomized and randomized block designs. Latin Square designs. Incomplete block design. Factorial design, 2^k factorial designs and blocking and confounding in 2^k factorial designs. Using statistical packages to analyze real data sets.

Prerequisites: Graduate Standing. Cannot be taken for credit with Math 560 or ISE 530. Cannot be taken by STAT major students.

Course Objectives: STAT511 is intended to be a foundation course in regression analysis and design and analysis of experiments. The emphasis is on understanding how to use regression analysis and 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 both regression analysis and experimental designs
- analyse the simple and multiple linear regression models in connection with ANOVA
- validate the assumptions of regression and design models through residual analysis
- develop the hypothesis test and confidence intervals for regression and design models
- demonstrate the model building techniques and analyze the model adequacy
- choose the best regression model using different variable selection techniques
- 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 various regression techniques on some relevant 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 Books:

1. *Applied Regression Analysis and Generalized Linear Models* by John Fox, 3rd edition, SAGE Publications 2015.
2. *Introduction to Linear Regression Analysis* by Montgomery, Peck and Vinning, 5th edition, Wiley (2012).

Assessment

Activity	Weight
Classwork (quizzes, assignments, attendance, etc.)	15%
Midterm Exam(s)	30%
Project	15%
Final Exam (Comprehensive)	40%

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 a maximum of 5 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 (Tentative)

Week	*Topics*	*Chapter Ref Book 1*	*Chapter Text Book*
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&3	Chapters 2
Week 2	**Introduction to design of experiments** • Defining experimental design • Basic principles of experimental designs • Introducing basic designs		Chapter 1
Week 3	**ANOVA models for experimental designs** • One way ANOVA model and its analysis • Two way ANOVA model and its analysis • Implementation of ANOVA models using RStudio		Chapter 3
Week 4	**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 5	**Analysis of covariance using ANCOVA models** • Role of covariates in DOE • ANCOVA models and their analysis • Implementation of ANCOVA using RStudio		Chapter 15
Week 6	**Factorial Designs** • Multi factor experiments and their graphical analysis • Conducting factorial experiments using basic designs • Implementation of factorial designs using RStudio		Chapter 5
Week 7	**2^k factorial designs and confounding** • Level 2 factorial designs • Sign table, Yate's algorithm, modulu 2 method for linear contrasts • Confounded designs • Implementation of 2^k designs using RStudio		Chapter 6&7
Week 8	**Introduction to regression** • An introduction to regression modelling • Exploring R and RStudio including libraries and packages, exporting Excel and text files, performing basic statistical analysis in RStudio	Chapter 2	Chapter 10
Week 9	**Simple linear regression models (SLR)** • Simple linear regression model and its estimation using least-square method • Hypothesis testing and confidence intervals for regression parameters Analysis of variance technique and its role in regression analysis	Chapters 5&8	Chapters 10
Week 10	**Simple linear regression models (SLR) (cont.)** • Prediction of new observations for individual and mean values • Regression through the origin as a special case • Implementation of simple linear regression using RStudio	Chapter 6	Chapter 10
Week 11	**Multiple linear regression models (MLR)** • Multiple linear regression model and its estimation using least-square method • Individual hypothesis testing and confidence intervals • Prediction of individual and mean values	Chapter 5	Chapter 10
Week 12	**Multiple linear regression models (MLR) (cont.)** • Measures of variation with multiple independent variables • Overall F-test for significance • Partial F-test: Testing for the significance of portions of the model	Chapters 6&8	Chapters 10
Week 13	**Multiple linear regression models (MLR) (cont.)** • Pitfalls and issues in multiple linear regression (hidden extrapolation) • Standardized regression coefficient • Implementation of multiple linear regression using RStudio	Chapters 6&8	Chapters 10
Week 14	**Variable selection and model building** • Approaches to model building • Strategy for variable selection • Implementation of feature selection using RStudio	Chapter22	Chapter 10
Week 15	**An introduction to some selective topics in experimental designs and regression analysis (depending on time availability)** • Split plot designs • Split-split plot designs • Implementation of split plot designs using RStudio		Chapter 14
Week 16	**Review**		

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 (Exam I, Exam II, or the Final Exam) for a legitimate reason (such as medical emergencies), he must bring an official excuse from Students Affairs. Otherwise, he 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 (6 lectures) or 33.3% excused and unexcused absences (10 lectures).

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.