# King Fahd University of Petroleum and Minerals
## Department of Mathematics
## STAT 513 Syllabus, Term 251 (2025-26)
**Instructor: Dr. Nasir Abbas ( nasirabbas@kfupm.edu.sa )**

**Course Title:** Statistical Modelling

**Course Credit Hours:** 3-0-3

**Textbook:** A. Agresti. Foundations of Linear and Generalized Linear Models, Wiley (2015).

**Reference Books:**

- Linear Regression Models - Applications in R by John P. Hoffman, Chapman & Hall/CRC (2021).
- Introduction to Linear Regression Analysis by Montgomery, Peck and Vinning, 6th edition, Wiley (2021).
- An Introduction to Statistical Learning with Applications in R by G. James, D. Witten, T. Hastie and R. Tibshirani, 2nd Edition, Springerlink 2021.

**Software Package**: R language and R studio.

**Course Objective:**

- Introduce statistical tools for modeling;
- Develop models that learn from the observed data;
- Implement statistical models based on the statistical analysis.

**Course Description:** Statistical tools for learning from the data by doing statistical analysis on the data with an emphasis on the implementation using various software, toolboxes, and libraries like R, Scikit-Learn, and Stats models. Topics include simple and Multiple Linear Regression, Polynomial Regression, Splines, Generalized Additive Models; Hierarchical and Mixed Effects Models; Bayesian Modeling; Logistic Regression, Generalized Linear Models, Discriminant Analysis; Model Selection.
**Prerequisite:** MATH 102

**Course Learning Outcomes:** Upon successful completion of the course, a student should be able to

- Develop statistical models to describe the observed data using computational tools;
- Describe different statistical tools to analyze data;
- Measure the effectiveness of models;
- Present effectively through oral presentation and written reports outcome of the models;
- Interpret the statistical models.

**Grading Policy:**

| **Activity** | **Weight** |
|---|---|
| Classwork (quizzes, assignments, attendance, bonuses, etc.) | 15% |
| Project | 20% |
| Midterm Exam | 30% |
| Final Exam (Comprehensive) | 35% |

## Coverage Plan

| No | List of Topics | Contact hours |
|---|---|---|
| 1 | Statistical Learning<br>• What is Statistical Learning<br>• Descriptive Analysis<br>• Probability and Sampling Distributions<br>• Inferential Analysis<br>• Introduction to R language | 3 |
| 2 | Simple Linear Regression<br>• Estimating the Coefficients<br>• Assessing the Accuracy of the Coefficient Estimates<br>• Assessing the Accuracy of the Model | 3 |
| 3 | Multiple Linear Regression<br>• Estimating Regression Coefficients<br>• Some Important Questions<br>• Other Considerations in the Regression Model<br>• Qualitative Predictors<br>• Extensions of the Linear Model<br>• Model fitting using R | 6 |
| 4 | Polynomial Regression<br>• Introduction to Polynomial Regression<br>• Step Functions<br>• Basis Functions<br>• Polynomial Regression Fitting using R | 3 |
| 5 | Linear and Non-Linear Spline Fitting<br>• Regression Splines<br>• Piecewise Polynomials<br>• Constraints and Splines<br>• Smoothing Splines<br>• Spline Fitting using R | 3 |
| 6 | LOGIT and PROBIT models<br>• Models with a Binary Response Variable<br>• Logistic Regression Models<br>• Probit Regression Models<br>• Estimating the Parameters in a Logistic Regression Model<br>• Interpretation of the Parameters in a Logistic Regression Model<br>• Fitting LOGIT and PROBIT Models using R | 6 |
| 7 | Poisson Regression<br>• Introduction to Poisson Regression<br>• Application of Poisson Regression using R | 3 |
| 8 | Generalized Linear Models<br>• Link Functions and Linear Predictors<br>• Parameter Estimation and Inference in the GLM<br>• Prediction and Estimation with the GLM<br>• Residual Analysis in the GLM<br>• Using R to Perform GLM Analysis | 6 |
| 9 | Model Building Techniques<br>• Best Subset Selection<br>• Stepwise Selection<br>• Choosing the Optimal Model<br>• Model Selection Using R | 6 |

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|---|---|---|
| 10 | Bayesian Modeling<br>• Testing and Comparing Models<br>• Making the Most Accurate Predictions<br>• Interpreting Results Quickly & Effectively | 3 |
| 11 | Non-Linear Regression<br>• Linear and Nonlinear Regression Models<br>• Origins of Nonlinear Models<br>• Nonlinear Least Squares<br>• Transformation to a Linear Model<br>• Parameter Estimation in a Nonlinear System<br>• Statistical Inference in Nonlinear Regression<br>• Examples of Nonlinear Regression Models Using R | 3 |
| | **Total** | 45 |

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

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

**Cheating and Plagiarism:** Cheating or any attempt at 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, smart watches or any other electronic devices.

**Mobiles:** The use of mobiles is *strictly banned* during class. Students are required to keep their phones off/silent and placed inside their pockets during the class timings.

**Project:** Project Guidelines will be uploaded to Blackboard, and guidelines for the report will also be posted there. The instructor will form project groups.

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

**Attendance Notes:**

Students are expected to attend all lectures.

- If a student misses a class, he/she is responsible for any announcement made in that class.
- After being warned twice by the instructor, a DN grade will be awarded to any student who accumulates
  - 6 unexcused absences (20%), or,
  - 10 excused and unexcused absences (33%)

**Use of AI Tools (like ChatGPT):**

- Students are encouraged to use AI responsibly as a learning aid for understanding lecture content, practicing statistical concepts, and preparing for exams.
- However, the use of AI during quizzes and exams is *strictly prohibited* and will be treated as an academic integrity violation.