King Fahd University of Petroleum and Minerals
Department of Mathematics
MATH-405: Learning from Data (Term 241)

Course Description:
Basic vector and matrix operations, Factorizations, Basic Probability Theory, Inference, Least-Square Estimation, Maximum Likelihood Estimation, Gradient Descent. Applications to Machine Learning using Linear Regression and Neural Networks.

Course Learning Outcomes:
- Describe linear algebra and statistics fundamental to many machine learning algorithms;
- Apply linear algebra concepts to probability and statistics;
- Apply linear algebra to optimization problems;
- Use linear algebra and statistics in selected machine learning algorithms;
- Work individually or in teams.

Course Main Objectives:
- Introduce to the students linear algebra, statistics, and optimization related to data science.
- Enable the students to learn most of the matrix factorization methods
- Enable the students to learn Singular Vector Decomposition and Principal Components Analysis.
- Enable the students to learn Numerical Linear Algebra algorithms: Krylov Subsapces, Gram-Schmidt,...
- Enable the students to learn Matrix Completion and Gradient Descent Methods.
- Enable the students to learn some forecasting methods: Times series and linear regression, Neural Netwrorks

Prerequisite: MATH 102 and (STAT 201 or STAT 319 or ISE 205) and ICS 104.

Textbook: Linear Algebra and Learning from Data, by Prof. Gilbert Strang, WELLESLEY- CAMBRIDGE PRESS, 2018.

Software: SPSS and RStudio

Reference Book:
- Statistics: The Art and Science of Learning from Data by Agresti, Franklin and Klingenberg, 5th Edition, Pearson 2021.
- A Hands-On Introduction to Data Science by Chirag Shah, Cambridge University Press; 1st edition (April 2, 2020)

Assessment*

Activity	Weight
Quizzes and tests	10%
Major Exam I	25%
Major Exam II	25%
Project presentation and report	10%
Final Exam (Comprehensive)	30%

Important Notes:

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

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

Attendance Notes:

- In accordance with University rules, 20% unexcused absences will automatically result in a grade of DN.
- 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.

No	List of Topics	Contact hours
1	Introduction to Vectors and Matrices	3
2	Basic Operations on Vectors and Matrices with application in RStudio	6
3	Matrix Decomposition	3
4	Probability and Probability Distributions with application in RStudio	6
5	Statistical Inference with application in RStudio	6
6	Method of Least Squares Estimation with application in RStudio	3
7	Maximum Likelihood Estimation with application in RStudio	3
8	Gradient Descent Method with application in RStudio	3
9	Simple Linear Regression with application in RStudio	3
10	Multiple Linear Regression with application in RStudio	6
11	Neural Networks with application in RStudio	3
Total		**45**