KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DEPARTMENT OF MATHEMATICS

DHAHRAN, SAUDI ARABIA

MATH 503: Mathematics for Data Science

Term 211 – Fall 2021

Instructor: **Jaafar Almutawa**

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Office Hours: **UTW**:2:00 PM – 3:00 PM or by appointment

Prerequisite: Graduate Standing

Credit Hours: (3-0-3)

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Course Description:

Data transformation using linear algebra, vector spaces, linear transformations, matrix representations, matrix decompositions (eigenvectors, LU, QR, SVD, Cholesky); multivariate calculus for continuous, convex, and non-convex optimization methods; time series construction and visualization, Fourier transformations for time series conversion.

Course Material:

1. *Course Syllabus:* Posted on Blackboard.
2. *Textbook:* Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong.
3. *Notes:* Class Notes.

Communication:

For regular announcements, students are advised to check Teams and Blackboard regularly.

Grading:

Activity	Weight
Quizzes	10%
Homeworks	15%
Midterm exam	30%
Projects	5%
Final Exam	40%

Student Learning Outcomes:

Explain the mathematical background to solve data science problems
Identify the calculus, linear algebra, and optimization topics related to each step of a data science problem
Apply computational tools in data science problems
Analyze time series using Fourier transformation
Visualize time series data

Academic Integrity:

All KFUPM policies regarding **ethics** and **academic honesty** apply to this course

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

For ***Important Dates*** and ***Academic Calendar***, check the Registrar's site: **http://regweb.kfupm.edu.sa**

SCEDULE and COVERAGE of MATERIAL

Week No. *(Dates)*	Sections	Topics
Week 1 *Aug. 29- Aug. 31*	**Chapter 2** 2.1 2.2 2.3	**Linear Algebra** Systems of Linear Equations Matrices Solving Systems of Linear Equations
Week 2 *Sep. 5- 7*	2.4 2.5 2.6	Vector Spaces Linear Independence Basis and Rank
Week 3 *Sep. 12- 14*	2.7 2.8	Linear Mappings Affine Spaces
Week 4 *Sep. 19- 21*	**Chapter 3** 3.1 3.2 3.3 3.4	**Analytic Geometry** Norms Inner Products Lengths and Distances Angles and Orthogonality
Sep 23: National Day Holiday		
Week 5 *Sep. 26- Sep. 28*	3.5 3.6 3.7 3.8 3.9	Orthonormal Basis Orthogonal Complement Inner Product of Functions Orthogonal Projections Rotations
Week 6 *Oct. 3- 5*	**Chapter 4** 4.1 4.2 4.3	**Matrix Decomposition** Determinant and Trace Eigenvalues and Eigenvectors Cholesky Decomposition
Week 7 *Oct. 10- 12*	4.4 4.5	Eigendecomposition and Diagonalization Singular Value Decomposition
Oct. 17: Student Break		
Week 8 *Oct. 19*	4.6 4.7	Matrix Approximation Matrix Phylogeny
Week 9 *Oct. 24- 26*	**Chapter 5** 5.1 5.2 5.3	**Vector Calculus** Differentiation of Univariate Functions Partial Differentiation and Gradient Gradients of Vector-Valued Functions
Week 10 *Oct. 31- Nov. 2*	5.4 5.5	Gradients of Matrices Useful Identities for Computing Gradients
Week 11 *Nov. 7- 9*	5.6 5.7 5.8	Backpropagation and Automatic Differentiation Higher-Order Derivatives Linearization and Multivariate Taylor Series
Week 12 *Nov. 14- 16*	**Chapter 7** 7.1 7.2	**Continuous Optimization** Optimization Using Gradient Descent Constrained Optimization and Lagrange Multipliers
Week 13 *Nov. 21- 23*	7.3	Convex Optimization
Midterm Break Nov. 28- Dec 02		
Week 14 *Dec. 05- 07*	Lecture Notes	**Fourier Transformation for Time Series**

Week 15 *Dec. 12- Dec. 14*	Lecture Notes	**Fourier Transformation for Time Series**
Week 16 *Dec. 19*		Review
Dec 20	Normal Thursday Classes; Last day of classes for the term	
Final Exam (Comprehensive): TBA		