KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DEPARTMENT OF MATHEMATICS

DHAHRAN, SAUDI ARABIA

Term 221 – Fall 2022

MATH 503: Mathematics for Data Science.

Instructor: Ali N. Duman

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Office Hours:

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.

References:

1. Deisenroth etal: Mathematics for Machine Learning, 2021 (Main reference).

2. Charu C. Aggarwal, Linear Algebra and Optimization for Machine Learning, 2020.

Communication:

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

Academic Integrity:

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

Attendance: (As per KFUPM policy) **DN** is assigned for 20% (9) unexcused absences and 33% (15) overall absence (excused and unexcused)

Grading:

Activity	Weight
Classwork	10%
Quizzes	15%
Projects	40%
Midterm exam	15%
Final Exam	20%

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

SCHEDULE and COVERAGE of MATERIAL

Week No. (Dates)	Reference	Topics
Week 1	Chapter 2 2.4 2.2 2.1	**Linear Algebra** Matrices and sum algebra of matrices Vector Spaces Systems of Linear Equations
Week 2	2.5 2.6 2.3	Linear Independence Basis and Rank Solving Systems of Linear Equations
Week 3	2.7 2.8	Linear Mappings Affine Spaces
Week 4	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	3.5 3.6 3.7 3.8 3.9	Orthonormal Basis Orthogonal Complement Inner Product of Functions Orthogonal Projections Rotations
Week 6	Chapter 4 4.1 4.2 4.3	**Matrix Decomposition** Determinant and Trace Eigenvalues and Eigenvectors Cholesky Decomposition

Week 7	4.4 4.5	Eigendecomposition and Diagonalization Singular Value Decomposition
Week 8	4.6 4.7	Matrix Approximation Matrix Phylogeny
Week 9	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	5.4 5.5	Gradients of Matrices Useful Identities for Computing Gradients
Week 11	5.6 5.7 5.8	Backpropagation and Automatic Differentiation Higher-Order Derivatives Linearization and Multivariate Taylor Series
Week 12	Chapter 7 7.1 7.2	**Continuous Optimization** Optimization Using Gradient Descent Constrained Optimization and Lagrange Multipliers
Week 13	7.3	Convex Optimization
	Midterm Break	
Week 14	Lecture Notes	Fourier Transformation for Time Series
Week 15	Lecture Notes	Fourier Transformation for Time Series
Week 16		Review