KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPARTMENT OF MATHEMATICS & STATISTICS
DHAHRAN, SAUDI ARABIA

MATH 503: Mathematics for Data Science
Term 201 – Fall 2020

Instructor: Ali Nabi Duman
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Office Hours: UTR 12:10 – 13:00 or by appointment

Time: UT 17:40 – 18:55
Place: Zoom or Microsoft Teams otherwise Building 58 – Room 1045

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 Blackboard regularly.

Grading:

Activity	Weight
Classwork (Attendance+Quizzes)	10%
Midterm 1	15%
Midterm 2	15%
Project 1	10%
Project 2	10%
Project 3	10%
Project 4	10%
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

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

Week	Date	Section	Topics	Important Dates
1	**Aug 30th – Sept 3rd**	**Chapter 2** 2.1 2.2 2.3	**Linear Algebra** Systems of Linear Equations Matrices Solving Systems of Linear Equations	
2	**Sep 6th – Sep 10th**	2.4 2.5 2.6	Vector Spaces Linear Independence Basis and Rank	
3	**Sep 13th – Sep 17th**	2.7 2.8	Linear Mappings Affine Spaces	
4	**Sep 20th – Sep 22th**	**Chapter 3** 3.1 3.2 3.3 3.4	**Analytic Geometry** Norms Inner Products Lengths and Distances Angles and Orthogonality	**Sep 23-24: National Day Holidays**
5	**Sep 27th - Oct 1st**	3.5 3.6 3.7 3.8 3.9	Orthonormal Basis Orthogonal Complement Inner Product of Functions Orthogonal Projections Rotations	**Project 1**
6	**Oct 4th - Oct 8th**	**Chapter 4** 4.1 4.2 4.3	**Matrix Decomposition** Determinant and Trace Eigenvalues and Eigenvectors Cholesky Decomposition	**Midterm 1**
7	**Oct 11th – Oct 15th**	4.4 4.5	Eigendecomposition and Diagonalization Singular Value Decomposition	**Project 2**
8	**Oct 18th – Oct 22st**	4.6 4.7	Matrix Approximation Matrix Phylogeny	
9	**Oct 25th – Oct 29th**	**Chapter 5** 5.1 5.2 5.3	**Vector Calculus** Differentiation of Univariate Functions Partial Differentiation and Gradient Gradients of Vector-Valued Functions	
10	**Nov 1st – Nov 5th**	5.4 5.5	Gradients of Matrices Useful Identities for Computing Gradients	**Project 3**
11	**Nov 8th – Nov 12th**	5.6 5.7 5.8	Backpropagation and Automatic Differentiation Higher-Order Derivatives Linearization and Multivariate Taylor Series	
12	**Nov 15th – Nov 19th**	**Chapter 7** 7.1 7.2	**Continuous Optimization** Optimization Using Gradient Descent Constrained Optimization and Lagrange Multipliers	**Midterm 2**
13	**Nov 22th – Nov 26th**	7.3	Convex Optimization	
14	**Nov 29th – Dec 3rd**	Lecture Notes	**Fourier Transformation for Time Series**	
15	**Dec 6th – Dec 10th**	Lecture Notes	**Fourier Transformation for Time Series**	**Project 4**