

**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 <i>Aug. 29- Aug. 31</i>	<b>Chapter 2</b>	<b>Linear Algebra</b>
	2.1	Systems of Linear Equations
	2.2	Matrices
Week 2 <i>Sep. 5- 7</i>	2.3	Solving Systems of Linear Equations
	2.4	Vector Spaces
	2.5	Linear Independence
Week 3 <i>Sep. 12- 14</i>	2.6	Basis and Rank
	2.7	Linear Mappings
Week 4 <i>Sep. 19- 21</i>	2.8	Affine Spaces
	<b>Chapter 3</b>	<b>Analytic Geometry</b>
Week 5 <i>Sep. 26- Sep. 28</i>	3.1	Norms
	3.2	Inner Products
	3.3	Lengths and Distances
	3.4	Angles and Orthogonality
<b>Sep 23: National Day Holiday</b>		
Week 6 <i>Oct. 3- 5</i>	3.5	Orthonormal Basis
	3.6	Orthogonal Complement
	3.7	Inner Product of Functions
	3.8	Orthogonal Projections
	3.9	Rotations
Week 7 <i>Oct. 10- 12</i>	<b>Chapter 4</b>	<b>Matrix Decomposition</b>
	4.1	Determinant and Trace
	4.2	Eigenvalues and Eigenvectors
Week 8 <i>Oct. 19</i>	4.3	Cholesky Decomposition
	4.4	Eigendecomposition and Diagonalization
Week 9 <i>Oct. 24- 26</i>	4.5	Singular Value Decomposition
	<b>Oct. 17: Student Break</b>	
Week 10 <i>Oct. 31- Nov. 2</i>	4.6	Matrix Approximation
	4.7	Matrix Phylogeny
Week 11 <i>Nov. 7- 9</i>	<b>Chapter 5</b>	<b>Vector Calculus</b>
	5.1	Differentiation of Univariate Functions
	5.2	Partial Differentiation and Gradient
Week 12 <i>Nov. 14- 16</i>	5.3	Gradients of Vector-Valued Functions
	5.4	Gradients of Matrices
Week 13 <i>Nov. 21- 23</i>	5.5	Useful Identities for Computing Gradients
	5.6	Backpropagation and Automatic Differentiation
	5.7	Higher-Order Derivatives
Week 14 <i>Dec. 05- 07</i>	5.8	Linearization and Multivariate Taylor Series
	<b>Chapter 7</b>	<b>Continuous Optimization</b>
Week 15 <i>Dec. 12- 14</i>	7.1	Optimization Using Gradient Descent
	7.2	Constrained Optimization and Lagrange Multipliers
Week 16 <i>Dec. 19- 21</i>	7.3	Convex Optimization
	<b>Midterm Break Nov. 28- Dec 02</b>	
Week 17 <i>Dec. 26- 28</i>	Lecture Notes	<b>Fourier Transformation for Time Series</b>

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