King Fahd University of Petroleum and Minerals
Department of Mathematics
Math 503 – Syllabus
Semester 222
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Title Mathematics for Data Science

Credit 3-0-3

Textbook
1. Deisenroth et al: Mathematics for Machine Learning, 2021 (Main Reference)
2. Charu Aggarwal, Linear Algebra and Optimization for Machine Learning
3. Hagan M. et al., Neural Network Design

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.

Prerequisite: Graduate Standing

Grading Policy:

Presentation	CW+HW	Projects	Exams	Final Exam
15%	5%	20%	30%	30%

Learning outcomes: Upon completion of this course, each student should be able to:

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

PACING SCHEDULE

Week	Date	Section	Topic
1	Jan. 15 – Jan. 19	2.1	Systems of Linear Equations
		2.2	Matrices
		2.3	Solving Systems of Linear Equations
2	Jan. 22 – Jan. 26	2.4	Vector Spaces
		2.5	Linear Independence
		2.6	Basis and Rank
3	Jan. 29 – Feb. 02	2.7	Linear Mappings
		2.8	Affine Spaces
4	Feb. 05 – Feb. 09	3.1	Norms
		3.2	Inner Products
5	Feb. 12 – Feb. 16	3.3	Lengths and Distances
		3.4	Angles and Orthogonality
		3.5	Orthonormal Basis
		3.6	Orthogonal Complement
6	Feb. 19 – Feb. 23	3.7	Inner Product of Functions
		3.8	Orthogonal Projections
		3.9	Rotations
	Wednesday, Thursday:	**Feb. 22, 23:**	**Saudi Founding Day**
7	Feb. 26 – Mar. 02	4.1	Determinant and Trace
		4.2	Eigenvalues and Eigenvectors
		4.3	Cholesky Decomposition
8	Mar. 05 – Mar. 09	4.4	Eigen decomposition and Diagonalization
		4.5	Singular Value Decomposition
9	Mar. 12 – Mar. 16	4.6	Matrix Approximation
		4.7	Matrix Phylogeny
10	Mar. 19 – Mar. 23	5.1	Differentiation of Univariate Functions
		5.2	Partial Differentiation and Gradient
		5.3	Gradients of Vector-Valued Functions
11	Mar. 26 – Mar. 30	5.4	Gradients of Matrices
		5.5	Useful Identities for Computing Gradients
		5.6	Backpropagation and Automatic Differentiation

12	Apr. 02 – Apr. 06	5.7	Higher-Order Derivatives
		5.8	Linearization and Multivariate Taylor Series
13	Apr. 09 – Apr. 13	Presentations	
	Apr.14 - Apr.27, 2023:	**Eid Al-Fitr Holidays**	
14	Apr. 30 – May 04	7.1	Optimization Using Gradient Descent
		7.2	Constrained Optimization and Lagrange Multipliers
15	May 07 – May 11	7.3	Convex Optimization
16	May 14 – May 15		Review/Catching up

Homework:

There will be no HW to submit. However, I encourage you to form study groups, help each other, and solve as many problems as you can, since the only way to learn Mathematics is to do Mathematics!.

Office Hours:

Every Monday and Wednesday 03PM to 04PM. Try solving the problem before asking about it in the office hours.

Exams:

There will be three major exams and a final exam. There are no makeup exams.

Exam 1: February 07, 2023

Exam 2: March 07, 2023

Exam 3: April 04, 2023

Remark:

Above all, I hope you have fun in this course. This is one of my main two goals in the course (the other one is, of course, to learn basics of Linear Algebra).