



COURSE SYLLABUS

I-Course Information :

Title of the course	Linear Algebra
Department	Data Science
Specialization	
Academic Year	2020-2021
Semester Duration	3 months
Credit Number	4
Number of Hours	40
Course Instructor	Rabih Assaf
Email	rabih.assaf@ul.edu.lb rabih_assaf@hotmail.com
Office Hours	Friday 8:00 to 12:00

II- Course Description

Linear algebra is one of the most important set of tools in applied mathematics and data science. In this course, you'll learn how to work with vectors and matrices, solve matrix-vector equations, perform eigenvalue/eigenvector analyses and use principal component analysis to do dimension reduction on real-world datasets.

III-Course Objectives

This course aims to provide students with/allows students to:

- ❖ Prove algebraic properties for matrix addition, scalar multiplication, transposition, and matrix multiplication. Apply these properties to manipulate an algebraic expression involving matrices.
- ❖ Compute the inverse of a matrix using row operations, and prove identities involving matrix inverses.
- ❖ Solve a linear system using matrix algebra.
- ❖ Evaluate the determinant of a square matrix using either Laplace Expansion or row operations.
- ❖ Understand basic properties of vector spaces.
- ❖ Find eigenvalues and eigenvectors for a square matrix. Determine when it is possible to diagonalize a matrix.
- ❖ Deal with several types of decomposition, projections, orthogonalization and orthonormalization.
- ❖ Manipulate complex numbers and solving quadratic equations in the space of complex numbers.
- ❖ Convert points between Cartesian, polar, cylindrical, and spherical coordinates.

In order to achieve the objectives of the course, the following requirements must be met by the student:

- Scientific activities
- Academic regulations
- Academic work and perseverance



- 70% attendance and participation

IV- Course Outline and Calendar

Learning Objective	Session(s)	Learning Content	Pedagogical Strategy& Tools
Chapter 1 - Matrices	1-2-3-4	• Definition and properties of matrix • The transpose of a matrix • The identity and inverse matrices • Finding the Inverse of a matrix • Elementary matrices.	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course + extra exercises as homework.
Chapter 2 - Determinants	5-6-7-8	• Basic Techniques and properties • Determinants of a triangular matrix • Determinants by row operations • Applications of the Determinant • Formula for the Inverse • Cramer's Rule	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course + extra exercises as homework.
Chapter 3 – System of equations	9-10-11-12	• System of linear equations, • Homogeneous system of an equation, • Gaussian elimination • Rank and solutions to a system of equations • LU Decomposition	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course + extra exercises as homework.
Midterm			
Chapter 4 - Spectral Theory	13-14-15-16	• Eigenvalues and Eigenvectors of a Matrix • Diagonalization of a matrix • Eigen decomposition	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course + extra exercises as homework.
Chapter 5 – Vector spaces	17-18-19-20	• Algebraic considerations • Linear Independence • Norms of vector spaces	Explanations of definitions, theorems and methods with direct applications, then solving



			a work sheet of exercises at the end of the course + extra exercises as homework
Chapter 6 – Advanced topics for Machine Learning	21-22-23-24	- QR decomposition, factorization - Orthogonalization, and orthonormalization - Projections	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course + extra exercises as homework.
Chapter 6 – Complex numbers	25-26-27	- Complex numbers definitions - Polar form - Roots of complex Numbers - The Quadratic Formula	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course + extra exercises as homework.
Final Exam			

P.S.: The course outline above may be modified during the semester.

V- Teaching approach & methods

The goal in my classroom is to have a lively, open, and educational environment. Therefore, the use of many methods and strategies of modern learning will be concentrated in class:

- Emphasizing class participation.
- Encouraging discussion and interaction
- Bringing excitement and a storyline to classes, using energy and enthusiasm to teach ideas while guiding students along a path where each new concept is a natural consequence of the previous and a natural precursor to the following.
- Focusing on higher order thinking skills and promoting students' critical thinking in self-directed and safe learning environments.
- Providing active learning: showing problem-solving techniques, and making mistakes, getting stuck, and trying different strategies.
- Combination of theoretical and practical parts of the course
- Active learning outside the class room providing homeworks and online resources.
- Focusing on the importance of the course in the major and its relation with other courses.
- Showing real life and practical examples of the development of linear algebra tools in the world of Data Science.
- Continuous assessments thought the learning schedule.

VI- Assessment Methods

The success of the student in this course is based on:

- 1- His/her active participation in class.
- 2- His/her scientific contribution through research done outside the classroom.
- 3- His/her reading notes, research reports and practical applications as requested by course instructor.

The assessment of the student is carried out according to the following grid:



Assessment Type	Final Grade Weighting (%)	Dates/Deadlines
Participation (projects, research paper, oral presentation, etc.)	20%	Continuous Assessments
Midterm Exam	20%	January
Final exam	60%	February/March
Total	100%	

VII- Specific Course Requirements

1- Regulations concerning deadlines for written and applied work submissions

The teacher has the right to:

- Refuse to receive written applied work outside the deadlines.
- Give the student additional time after omitting up to 25% of the mark awarded to the concerned activity.

2- Academic measures in case of plagiarism

The student shall be liable to the following penalties in case of any attempt of illicit scientific citation:

- Cancellation of the student's contribution, activity or scientific article and reduction of the final mark.
- If the same offense is reported in other courses, cancellation of the final exam and failure in the relevant course(s).

VIII- Reference Book

- Elementary linear algebra : applications version / Howard Anton, Chris Rorres, 11th edition, Wiley, November 2013.
- Mark Deisenroth, Aldo Faisal, Cheng Soon Ong, mathematics for machine learning, Cambridge University, 2020.

IX- Bibliography& Additional Sources

- Linear Algebra and learning from data, Gilbert Strang, Massachusetts Institute of Technology, January 2019.
- Linear Algebra, Theory And Applications Kenneth Kuttler , Saylor Foundation, January 29, 2012
- Introduction to Applied Linear Algebra: Vectors, matrices, and Least Squares, Stephen Boyd, Stanford University, Lieven Vanderbergh, University of California, Cambridge University Press 2018.
- Linear Algebra, David Cherney, Tom Denton, Rohit Thomas and Andrew Waldron, Edited by Katrina Glaeser and Travis Scrimshaw First Edition. Davis California, 2013.
- Exercises and Problems in Linear Algebra John M. Erdman Portland State University Version July 13, 2014

