

## Linear Algebra for Data Science and Artificial Intelligence E-Syllabus

1	<b>Course title</b>	Linear Algebra for Data Science and Artificial Intelligence
2	<b>Course number</b>	1914101
3	<b>Credit hours</b>	3
	<b>Contact hours (theory, practical)</b>	3
4	<b>Prerequisites</b>	Discrete Mathematics (1901101)
5	<b>Program title</b>	Data Science
6	<b>Program code</b>	04
7	<b>Awarding institution</b>	The University of Jordan
8	<b>School</b>	King Abdullah II School for Information Technology
9	<b>Department</b>	Information Technology
10	<b>Level of course</b>	Undergraduate (UG)
11	<b>Year of study and semester (s)</b>	2021 - Spring
12	<b>Final Qualification</b>	BSc
13	<b>Other department(s) involved in teaching the course</b>	None
14	<b>Language of Instruction</b>	English
15	<b>Teaching methodology</b>	<input type="checkbox"/> Blended <input checked="" type="checkbox"/> Online
16	<b>Electronic platform(s)</b>	<input checked="" type="checkbox"/> Moodle <input checked="" type="checkbox"/> Microsoft Teams <input type="checkbox"/> Skype <input checked="" type="checkbox"/> Zoom <input checked="" type="checkbox"/> Others <a href="http://omar.alkadi.net/">http://omar.alkadi.net/</a>
17	<b>Date of production/revision</b>	18 February 2021

### 18 Course Coordinator:

Name: Dr. Omar Al-Kadi  
Office number: 308  
Phone number: 22623  
Email: o.alkadi@ju.edu.jo

### 19 Other instructions:

- Textbook: Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares can be downloaded from [here](#).
- Python Language Companion to Introduction to Applied Linear Algebra: Vectors, Matrices, and Least Squares can be downloaded from [here](#).

## 20 Course Description:

The aim of this course is to provide an introduction to vectors, matrices, and least square methods, all basic topics in linear algebra, in the context of data science and artificial intelligence.

## 21 Course aims and outcomes:

### A- Aims:

On completion of this course, students should be able to:

- Understand basic concepts of linear algebra (systems of linear equations, matrix calculus, vectors and basic vector operations)
- Enhance problem-solving abilities to analyse mathematical arguments.
- Understand how linear algebra can be applied to solve computational problems in data science
- Perform linear algebra computations in Python programming language

### B- Intended Learning Outcomes (ILOs):

Upon successful completion of this course, students will be able to:

On successfully completing the module, the students are expected to have gained good knowledge of:

No.	Course Intended Learning Outcomes (CILOs)
	<b>Knowledge</b>
A	Solve linear equations using Gaussian elimination and matrix inversion.
B	Carry out matrix operations, including inverses and determinants.
C	Demonstrate understanding of vector space and subspace.
D	Demonstrate understanding of linear independence, span, and basis.
E	Apply principles of matrix algebra to linear transformations.
F	Determine eigenvalues and eigenvectors and solve eigenvalue problems.
	<b>Professional Skill</b>
G	Demonstrate how to solve practical linear algebra in Python programming language
H	Demonstrate teamwork and communication skills through group work activities

## 22. Topic Outline and Schedule:

Week	Lecture	Topic	Teaching Methods*/platform	Evaluation Methods**	References
1	1.1	<b>Introduction to Linear Algebra</b>	Synchronous	Online class discussion and participation	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	1.2		Synchronous		
	1.3		Asynchronous		
2	2.1	<b>Vectors:</b> addition, scalar multiplication, inner product.	Synchronous	Assignment	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	2.2		Synchronous		
	2.3		Asynchronous		
3	3.1	<b>Linear functions:</b> linear functions, Taylor approximation and regression model.	Synchronous	Quiz	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	3.2		Synchronous		
	3.3		Asynchronous		
4	4.1	<b>Norm and distance:</b> norm, distance, standard deviation, angle, complexity.	Synchronous	Assignment	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	4.2		Synchronous		
	4.3		Asynchronous		
5	5.1	<b>Clustering:</b> norm, distances, clustering, the $k$ -means algorithm.	Synchronous	Online class discussion and participation	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	5.2		Synchronous		
	5.3		Asynchronous		
6	6.1	<b>Linear independence:</b> linear dependence, basis, orthonormal vectors.	Synchronous	Assignment	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	6.2		Synchronous		
	6.3		Asynchronous		
7	7.1	<b>Matrices:</b> zero and identity matrices, transpose, addition, and norm, matrix-vector multiplication.	Synchronous	Quiz	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	7.2		Synchronous		
	7.3		Asynchronous		
8	8.1	<b>Matrices:</b> geometric transformations, selectors, incidence matrix, convolution	Synchronous	Assignment	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	8.2		Synchronous		
	8.3		Asynchronous		
9	9.1		Synchronous	Quiz	

	9.2	<b>Matrices:</b> linear and affine functions.	Synchronous		Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	9.3		Asynchronous		
10	10.1	<b>Matrices:</b> matrix multiplication, composition of linear functions, matrix power, QR factorization	Synchronous	Online class discussion and participation	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	10.2		Synchronous		
	10.3		Asynchronous		
11	11.1	<b>Matrices:</b> inverse matrices, eigenvalues and eigenvectors.	Synchronous	Quiz	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	11.2		Synchronous		
	11.3		Asynchronous		
12	12.1	<b>Least squares:</b> least square problem	Synchronous	Online class discussion and participation	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	12.2		Synchronous		
	12.3		Asynchronous		
13	13.1	<b>Least squares:</b> least square problem, least square data fitting.	Synchronous	Online class discussion and participation	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	13.2		Synchronous		
	13.3		Asynchronous		
14	14.1	<b>Least squares:</b> least squares data fitting, validation, feature engineering	Asynchronous	Online class discussion and participation	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	14.2		Asynchronous		
	14.3		Asynchronous		
15	15.1	<b>Least squares:</b> classification, least squares classifier, multi-class classifiers	Synchronous	-	Moodle ( <a href="http://elearning.ju.edu.jo">http://elearning.ju.edu.jo</a> ) and subject webpage ( <a href="http://omar.alkadi.net/2030-2">http://omar.alkadi.net/2030-2</a> )
	15.2		Synchronous		
	15.3		Asynchronous		

- Teaching methods include: Synchronous lecturing/meeting; Asynchronous lecturing/meeting
- Evaluation methods include: Homework, Quiz, Exam, pre-lab quiz...etc.

### 23 Evaluation Methods:

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements:

Evaluation Activity	Mark	Topic(s)	Period (Week)	Platform
First quiz	4 marks	Vectors & linear functions	Week 3	Moodle

First and second assignment	2 marks	Vectors, linear functions, and norm and distance	Week 2 and 4	Google Classroom
Midterm exam	30 marks	Vectors, linear functions, norm and distance, clustering, linear independence, and matrices	Week 7	Moodle
Third and fourth assignment	2 marks	linear independence, and matrices	Week 6 and 8	Google Classroom
Hands-on programming quiz	3 marks	Vectors, linear functions, norm and distance, clustering, linear independence, and matrices	Week 11	Moodle
Third quiz	4 marks	Least squares	Week 13	Moodle

**24 Course Requirements (e.g: students should have a computer, internet connection, webcam, account on a specific software/platform...etc):**

PC/laptop, Python – Anaconda distribution, Jupyter Notebook.

**25 Course Policies:**

A- Attendance policies: Students are responsible for attending online lectures and downloading and viewing all material covered uploaded to the LMS (<http://elearning.ju.edu.jo>) and the subject webpage at (<http://omar.alkadi.net/2030-2>).

B- Absences from exams and submitting assignments on time: It is the students' responsibility to turn in their homework assignments to their instructors by the announced due date/time. Not attending exams without a valid excuse is not accepted.

C- Health and safety procedures: Students should adhere to the University of Jordan health and safety rules and procedures

D- Honesty policy regarding cheating, plagiarism, misbehavior: For more details on University regulations please visit <http://www.ju.edu.jo/rules/index.htm>

E- Grading policy: 50% semester work comprising of assignments, quizzes and programming project to be submitted at the end of the semester, and 50% for final exam.

F- Available university services that support achievement in the course: <http://elearning.ju.edu.jo>

**26 References:**

A- Required book(s), assigned reading and audio-visuals:

- *Introduction to Applied Linear Algebra: Vectors, Matrices, and Least Squares*, by Stephen Boyd and Lieven Vandenberghe, (Cambridge University Press, 3rd edition)

B- Recommended books, materials and media:

- *Introduction to Linear Algebra*, by Gilbert Strang, (Wellesley Cambridge Press, 5<sup>th</sup> Ed).
- *Contemporary Linear Algebra*, by Anton and Busby, (Wiley).
- *Elementary Linear Algebra; applications version*, by Anton, H., Rorres, C., (Wiley, 12<sup>th</sup> Ed).
- *Linear Algebra and its Applications*, by Lay, David C., (Addison Wesley, 2<sup>nd</sup> Ed).
- *Linear Algebra with Applications*, by Leon, Steven J., (Prentice Hall, 6<sup>th</sup> Ed).
- *Applied Linear Algebra*, by Noble, B. and Daniel, J., (Prentice-Hall, 3<sup>rd</sup> Ed).

## 27 Additional information:

For additional information, student can refer to the lecturers' website at <http://omar.alkadi.net/teaching>