# MAT350
# Applied Linear Algebra

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Hours: 45
Credits: 6 ECTS
Prerequisites: basic calculus and algebra
Instructor name: to be determined
E-mail: @nebrija.es
Office hours: to be communicated the first day of class

## 1. Course Description

The course will focus on matrix and vector methods for studying systems of linear equations, with an emphasis on concrete calculations and applications. Specific topics to be covered include matrices, Gaussian elimination, vector spaces, LU decomposition, orthogonality, the Gram–Schmidt process, determinants, inner products, eigenvalue problems, and applications to differential equations and Markov processes.

## 2. Learning Objectives

Students who successfully complete this course will be able to:

• Use matrices to solve linear systems of equations;

• Verify whether a given set is a vector space;

• Find bases of subspaces;

• Find matrix representations of linear transformations and use them in applied problems;

• Determine eigenvalues and bases of eigenspaces;

• Determine and use matrix factorizations such as LU, QR and SVD;

• Enhance their understanding of the above concepts through occasional MATLAB-based homework problems.

## 3. Methodology

The majority of the course syllabus follows the main methodological guidelines of the Communicative Approach, based on the core principles of procedure conception and constructive acquisition of knowledge. The methodology is based on the teaching-learning procedures, focused on the learner, which encourages active participation and results in the development of general and specific competencies that prove knowledge, capacities and attitudes for their future professional careers.

## 4. Evaluation

The form of assessment is based on the core principles of the educational assessment, i.e., an active and participative teaching-learning process focused on the learner. The instructor uses numerous and differentiated forms of assessment to calculate the final grade received for this course. For the record, these are listed below. The content, criteria and specific requirements for each assessment category will be explained in greater detail in class.

## 5.1. Grading system

In the Spanish educational system, it is required to quantitatively express the result of each student's evaluation. In order to do so, Nebrija faculty uses different strategies and instruments such as: papers,

exams, tests, projects, self-evaluation activities, etc. In order to issue a final grade for the Spanish Plus programs the following scale is established:

- 30 % Attendance and active participation in class
- 30% Daily work/ Papers/ Essays
- 40% Exams/ Final papers or projects**

Therefore, the final grade is the average between attendance and participation, daily work and exams, presentations, projects and essays.

Active participation in class is evaluated by means of different activities such as:

- Activities and exercises correction;
- Reflection upon the different contents in the course;
- Oral activities (individual, in pairs or in groups). Fluency, correction, adequacy and relevance are taken into account.

Daily work makes reference to any activity or task that is done inside or outside of the classroom, whether during the class time or at any other time.

Exams/ Final papers or projects

The course includes a midterm and a final written exam on theoretical concepts and course facts. If a student, unjustifiably, does not do or submit an exam, paper or project, it will be graded with a '0'.

## 5.2. Attendance, participation and grading policies

## 5.2.1. Attendance policy

Attendance is mandatory. In case of missing 7 or more sessions in one course, the student will receive a zero in his/her participation and attendance grade. In addition, not attending classes will not excuse the student from handing in in any homework, papers or essays previously assigned.

The following situations must be considered:

- Each session of class will count as an absence.
- Two delays of more than 15 minutes will be considered an absence. The entrance to class will not be allowed after 30 minutes once it has started.
- There are no excused absences. E.g.: Not attending class because of sickness will count as an absence. The student is responsible for catching up with any homework done while absent.
- Exams dates have been officially approved by the university, therefore, they will not be changed*

*Except for those courses where the professor will set up specific dates and inform the students at the beginning of the program.

## 5.2.2. Criteria to evaluate participation

| Criteria to evaluate participation | Grade |
|---|---|
| The student participates very actively in the class activities. S/he successfully does the requested tasks. S/he contributes to a good development of the course, encourages his/her classmates and favor debate in class. | 8.5 - 10 |
| The student participates actively in the class activities. S/he does the requested tasks and submits them on time. Shows great interest to learn. | 7 - 8.4 |
| The student, occasionally, makes interesting remarks, but s/he basically answers when s/he is asked.  S/he does not show a clear interest in the course. Misses classes occasionally. | 5 - 6.9 |

| The student does not participate unless s/he is asked. S/he has unjustified absences and delays. His/her attitude is not very participative. | 0 - 4.9 |
|---|---|

## 5.2.3. Criteria to evaluate Daily Work

| Criteria to evaluate Daily Work | Grade |
|---|---|
| The student always does all the work demanded by the professor, not only during the class but also at home. He/she always or almost always meets the deadlines established. | 8.5 - 10 |
| The student almost always does all the work demanded by the professor, not only during the class but also at home. Occasionally, he/she submits work after the established deadline. | 7 - 8.4 |
| The student occasionally does the work demanded by the professor, not only during the class but also at home. He/she does not normally meet the established deadlines and even occasionally does not submit the work. | 5 - 6.9 |
| The student never or almost never does the work demanded by the professor. He/she never or almost never meets the established deadlines. | 0 - 4.9 |

## 5.2.4. Grading criteria

| Number Grade | Letter Grade | Percentage |
|---|---|---|
| 10 | A+ | 100% |
| 9.5 – 9.9 | A | 95 – 99 % |
| 9 – 9.4 | A- | 90 – 94 % |
| 8.5 – 8.9 | B+ | 85 – 89 % |
| 7.5 – 8.4 | B | 75 – 84 % |
| 7 – 7.4 | B- | 70 – 74 % |
| 6.5 – 6.9 | C+ | 65 – 69 % |
| 6 – 6.4 | C | 60 – 64 % |
| 5 – 5.9 | C- | 5 – 59 % |
| 0 – 4.9 | F | 0 – 49 % |

## 5.3. Warning on plagiarism

When writing a University paper or essay and reference is made to certain authors, it is mandatory to cite them by means of a footnote or a direct reference. In no case it is acceptable that a student uses a text, no matter how brief it is, written by somebody else without putting it in inverted commas, as this means s/he is trying to make it look as his/her own. This is called plagiarism and in a university context it could be penalized with expulsion.

## 6. Bibliography

- Lay, David, (2015) *Linear Algebra and Its Applications*. 5th ed. Pearson.
- Strang, Gilbert, (2016*). Introduction to Linear Algebra*. 5th ed. Wellesley-Cambridge Press.

# 7. Office Hours

Tutorial schedule will be confirmed in the first couple of sessions, to guarantee that the time schedule suits the needs of students and instructor. However, it is always advisable to make an appointment with the lecturer beforehand in order to ensure availability.

Campus: Madrid Princesa
E-mail: to be determined

# 8. Course Content

| TOPICS | DESCRIPTION |
|---|---|
| 1. Gauss-Jordan elimination | • systems of linear equations<br>• Gauss-Jordan algorithm<br>• classification of solutions |
| 2. Matrix arithmetic | • addition and multiplication<br>• invertible matrices<br>• matrices with special shapes<br>• applications |
| 3. Determinants | • determinants and geometry<br>• cofactor expansion for the determinant<br>• properties of determinants |
| 4. Vectors | • $n$-dimensional space<br>• linear combinations and spanning<br>• vector spaces and dimension<br>• bases for the matrix subspaces<br>• general theory of linear systems |
| 5. Linear transformations and coordinates | • examples of linear transformations on euclidean spaces<br>• coordinates<br>• change of coordinates matrix |
| 6. Eigenvalues and eigenvectors | • theory for eigenvalues and eigenvectors<br>• linear independence of real eigenvectors<br>• invariants of linear transformations<br>• complex eigenvector examples<br>• diagonalization in complex case |
| 7. Linear geometry | • euclidean geometry<br>• orthogonal complements and projections<br>• least squares analysis<br>• conic sections and quadric surfaces |
| 8. Matrix factorizations | • LU factorization<br>• orthogonal matrices and the QR factorization<br>• singular value decomposition |