



MT 330 LINEAR ALGEBRA

IES Abroad Barcelona

DESCRIPTION:

Linear Algebra is the branch of mathematics that involves the study of solving systems of Linear Equations, vector spaces and linear mappings. The mastery of the subject is essential to any major related to applied and pure Mathematics and in particular to Engineering.

In this course, students will become proficient in the techniques of solving and manipulating systems. A particular focus of the course will be upon the applications of linear algebra to various Engineering fields. Among the most salient goals of the course will be an in-depth understanding of the primary theories as to why the techniques function as they do.

In particular, the course content covered during the semester is: Matrices, Determinants, Gaussian elimination, vector spaces, Linear Transformations, LU-decomposition, orthogonality, Gram-Schmidt process, inner products,

CREDITS: 3

CONTACT HOURS: 45

LANGUAGE OF INSTRUCTION: English

INSTRUCTOR: Pep Mateu

PREREQUISITES: Two semesters of College Calculus/Instructor's consent

ADDITIONAL COST: None

METHOD OF PRESENTATION:

The course uses the following methodology:

- **Lectures:** To introduce students to fundamental concepts. These lectures will be available on the Moodle site.
- **Resolution of problems:** A combination of theory and practical exercises in order to ensure that the concepts have been fully understood.
- **Study of didactic materials in Moodle:** Essential readings, videos and online resources are curated to help students develop a comprehensive grasp linear algebra and stimulate meaningful discussions.
- **Course-related trips:** These trips serve as a source of inspiration for students' designs and provide them with valuable opportunities to receive feedback from experts in the field.

REQUIRED WORK AND FORM OF ASSESSMENT:

This course uses continuous evaluation. The final grade will be calculated as follows:

- Class Participation: 10%
- Homework: 10%
- 2 exams: 80 %
 - Midterm exam: 40%
 - Final exam: 40%

Class participation: Students are expected to participate actively in the in-class activities and discussions.

Homework: There are 5 homework assignments with example problems, which are intended to prepare for the midterm and final exams.

Midterms and Final exams: These exams will combine multiple-choice questions with the resolution of problems.

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LEARNING OUTCOMES:

On successful completion of the course, students should be able to:

- Solve systems of linear equations, manipulate matrix algebra and determinants, apply row operations and elementary matrices.
- Analyze the concept and basic structure of vector spaces, give examples of vector spaces and examples of sets endowed with operations that are not vector spaces, explain the concept of dimension, apply the dimension theorem.
- Elucidate the null space, row space and column space of a matrix, apply the rank-nullity theorem.
- Give examples of linear transformations, determine whether or not a map is linear, evaluate the matrix representations of a linear transformation.
- Evaluate eigenvalues and eigenvectors, evaluate algebraic multiplicity and geometric multiplicity, diagonalize a matrix.
- Write simple proofs of statements related to the theory covered in the course.

ATTENDANCE POLICY:

As a member of our class community, you are expected to be present and on time every day. Attendance is required for all IES abroad Barcelona classes, including course-related excursions. If a student misses more than three classes without justification, three percentage points will be deducted from the final grade for every additional absence. Seven unjustified absences will result on a failing grade. Absences will only be justified in cases of documented medical or family emergencies.

CONTENTS:

Session	Content	Assignments
1	Linear Systems of Equations and Row Operations	All assigned readings are from the textbook unless otherwise specified: "Linear Algebra with Applications" (8th edition-International Edition) by Steven J. Leon University of Massachusetts Dartmouth, Prentice-Hall, 2009. ISBN-13: 978-013512867-1
2	Row-Echelon Form. Gauss-Jordan operations	Section 1.2
3	Matrix Arithmetic	• Section 1.3 • Homework 1: exercises in class.
4	Matrix Algebra	Section 1.4
5	Discussion Session 1: Section 1.1, exercises 2b, 2ad, 4a, 5b, 6b, 9, 10, 11 Section 1.2, exercises 5ad, 10, 13, 15 Section 1.3, exercises 6, 7, 13, 15, 16, 17 Section 1.4, exercises 3, 4, 5, 7, 10a, 18, 22, 24a, 31, 32, 33	Homework assignment 2
6	Elementary matrices; LU-decomposition	Section 1.5
7	Determinants. Computation by elimination and/or cofactors. Properties of determinants.	• Section 2.1, 2.2

		Deadline for submitting homework assignment 2
8	Cramer's Rule. Additional topics and applications: coding messages.	Section 2.3
9	Vector Spaces, definition and examples.	Section 3.1
10	Discussion Session 2: Section 1.5, exercises 3a, 6, 9, 10ae, 28 Section 2.1, exercises 4ac, 5, 5, 11 Section 2.2, exercises 4a, 7, 12 Section 2.3, exercises 1d, 2ab, 5, 14 Section 3.1, exercises 1, 4, 5, 6	Homework assignment 3
11	Vector Subspaces. Span of a set of vectors	Section 3.2
12	Linear independence	- Section 3.3 - Deadline for submitting homework assignment 3
13	MIDTERM EXAM	
14	Basis and dimension	Section 3.4
15	Change of Basis. Change of coordinates.	Section 3.5
16	Discussion Session 3: Section 3.2, exercises 1ad, 2ac, 3, 4ab, 11ab, 16a, 20 Section 3.3, exercises 1ac, 2ab, 3ab, 5, 9 Section 3.4, exercises 3, 4, 5, 9, 11 Section 3.5, exercises 1a, 2a, 4, 6, 9	Homework assignment 4
17	Row space and column space	Section 3.6
18	Linear Transformations, definitions and examples. Image and Kernel.	- Section 4.1 - Deadline for submitting homework assignment 4
19	Matrix representation of a Linear Transformation. Similarity.	Sections 4.2 and 4.3
20	The scalar product in real vector spaces.	Section 5.1
21	Discussion Session 4: Section 3.6, exercises 1a, 2a, 4abc, 5abc Section 4.1, exercises 2, 3, 5, 7ab, 19, 20. Section 4.2, exercises 2a, 3b, 5, 10a, 11a, 14b	Homework assignment 5

22	Orthogonal subspaces.	Section 5.2
23	Least squares problems. Inner product spaces. Cauchy-Schwarz inequality.	• Section 5.3, 5.4 • Deadline for submitting homework assignment 5
24	The Gram-Schmidt orthogonalization process and QR-factorization	Section 5.6, 5.7
	FINAL EXAM	

REQUIRED READINGS:

- "Linear Algebra with Applications" (8th edition-International Edition) by Steven J. Leon University of Massachusetts Dartmouth, Prentice-Hall, 2009. ISBN-13: 978-013512867-1

RECOMMENDED READINGS:

- Linear Algebra and Its Applications, 4/E David C. Lay, University of Maryland ISBN-10: 0321385179 • ISBN-13: 9780321385178 ©2012 • Pearson
- Linear Algebra and Its Applications, 4/E Gilbert Strang, Brooks Cole, ISBN 13: 978-0030105678

INSTRUCTOR BIOGRAPHY:

Born in Sant Pere de Vilamajor (Barcelona), Pep Mateu studied a math major at the Universitat Autònoma de Barcelona with a minor in Scientific Philosophy. Later, he continued his studies in University of Nebraska at Omaha, working as a GTA for the math department before coming back to Catalonia. Since then, he has been involved with several educational programs until September 2024, when he started teaching for IES Abroad.