DEGREE CURRICULUM

LINEAR ALGEBRA

Coordination: Jaume Giné Mesa

Academic year 2015-16

LINEAR ALGEBRA 2015-16

Subject's general information

Subject name	Linear Algebra
Code	102100
Semester	2n Q Continuous Evaluation
Typology	Troncal
ECTS credits	6
Groups	2
Theoretical credits	3
Practical credits	3
Coordination	Jaume Giné Mesa
Office and hour of attention	by appointment
Department	Matemàtica
Modality	Presencial
Important information on data processing	Consult this link for more information.
Language	Catalan
Degree	Degree in Automation and Industrial Electronic Engineering. Degree in Mechanical Engineering
Office and hour of attention	by appointment
E-mail addresses	gine@matematica.udl.cat

LINEAR ALGEBRA 2015-16

Jaume Giné Mesa

Subject's extra information

The couse requires continuous work throughout the semester in order to achieve the objectives. It requires critical thinking and capacity for abstraction. You can find collections of resolutions of exams of previous years (Technical Industrial Engineering) in the "Copisteria" of Cappont Campus (edifici de l'Aulari)) and at the Council Student of the EPS: http://www.consell-eps.udl.cat/ It is recommended to visit the Virtual Campus of the Course frequently where advertises all the relevant information.

Learning objectives

University of Lleida strategic competences

- Correctness in oral and written language.

  Objjectives

  - Analyze if a set of vectors is linearly independent or not
  - Describe vector spaces and subspaces
  - Apply Grassman formula
  - Determine the eigenvalues and eigenvectors associated to an endomorphism
  - Discuss and solve linear systems of equations
  - Reasoning and compare solutions
  - Summarising the statement of a problem to express it mathematically
  - Reasoning and analyze the results obtained from the calculation

Degree-specific competences

- Ability to resolve logical problems that can arise in engineering. Aptitude to apply knowledge about lineal algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial derivatives; numeric methods, numeric algorithms; statistics and optimization.

  Objectives

  - Operate with matrices: sum, product, transpose and inverse.
  - Perform Gauss elementary transformations in order to determine the rank of a matrix.
  - Compute determinants of square matrices of any order.
  - Discuss and solve linear systems of equations.
  - Solve systems by the method of Cramer.
  - Determine if a vector is a linear combination of a set of vectors.
  - Analyze if a set of vectors is linearly independent or not.
  - Describe vector spaces and subspaces.
  - Calculate the components of a vector in different bases. Applying the basis change matrix.
  - Determine the dimension of a vectorial subspace.
  - Perform subspace operations: intersection, sum and direct sum.
  - Apply Grassman formula.
  - Determine linear mappings from its image in a basis.
  - Calculate the kernel and the image of a linear transformation.
  - Relate the explicit expression of a linear transformation with its matricial expression.
  - Make calculations of a linear transformation in different basis. Apply the basis change matrix for these calculations.
  - Perform operations of linear applications: addition, multiplication by a scalar, composition.
  - Determine the eigenvalues and eigenvectors of an endomorphism.
  - Use Cayley-Hamilton theorem.
  - Determine whether or not an endomorphism diagonalizes.

- Apply the diagonalization of endomorphisms to determine powers of matrices.
- Apply the diagonalization of endomorphisms to solve linear recurrences.
- Apply the diagonalization of endomorphisms to solve differential systems of linear equations.
- Classify a bilinear form.
- Express a quadratic form as a sum of squares.
- Apply the scalar product of vectors to calculate distances and angles.
- Determine orthogonality between vectors.
- Apply the orthonormalization Gram-Schmidt process in order to compute orthonormal basis.
- Reasoning and compare solutions.
- Summarising the statement of a problem to express it mathematically.
- Use mathematical techniques to solve problems.
- Reasoning and analyze the results obtained from the calculation.

Degree-transversal competences

- Ability to gather and interpret relevant data in their field of study, and to emit judgements that include a reflection on relevant themes of a social, scientific or ethical nature

  Objectives

  - Apply the orthonormalization Gram-Schmidt process in order to compute orthonormal basis.
  - Reasoning and compare solutions.
  - Determine if a vector is a linear combination of a set of vectors.
  - Analyze if a set of vectors is linearly independent or not.
  - Describe vector spaces and subspaces.
  - Determine the dimension of a vectorial subspace.
  - Perform subspace operations: intersection, sum and direct sum.
  - Apply Grassman formula.
  - Determine linear mappings from its image in a basis.
  - Calculate the kernel and the image of a linear transformation.
  - Determine the eigenvalues and eigenvectors of an endomorphism.
  - Apply the scalar product of vectors to calculate distances and angles.
  - Determine orthogonality between vectors.

- Ability for abstraction and critical, logical and logical reasoning.

  Objectives

  - Perform Gauss elementary transformations in order to determine the rank of a matrix.
  - Discuss and solve linear systems of equations.
  - Determine if a vector is a linear combination of a set of vectors.
  - Analyze if a set of vectors is linearly independent or not.
  - Apply Grassman formula.
  - Determine linear mappings from its image in a basis.
  - Make calculations of a linear transformation in different basis. Apply the basis change matrix for these calculations.
  - Use Cayley-Hamilton theorem.
  - Apply the scalar product of vectors to calculate distances and angles.
  - Determine orthogonality between vectors.
  - Reasoning and compare solutions.
  - Summarising the statement of a problem to express it mathematically.
  - Reasoning and analyze the results obtained from the calculation.

- Ability to resolve problems and elaborate and defend arguments inside their field of study

  Objectives

  - Apply the diagonalization of endomorphisms to determine powers of matrices.

- Apply the diagonalization of endomorphisms to solve linear recurrences.
- Apply the diagonalization of endomorphisms to solve differential systems of linear equations.
- Determine whether or not an endomorphism diagonalizes.
- Operate with matrices: sum, product, transpose and inverse.
- Perform Gauss elementary transformations in order to determine the rank of a matrix.
- Compute determinants of square matrices of any order.
- Discuss and solve linear systems of equations.
- Solve systems by the method of Cramer.
- Determine if a vector is a linear combination of a set of vectors.
- Analyze if a set of vectors is linearly independent or not.
- Describe vector spaces and subspaces.
- Calculate the components of a vector in different bases. Applying the basis change matrix.
- Determine the dimension of a vectorial subspace.
- Perform subspace operations: intersection, sum and direct sum.
- Apply Grassman formula
- Determine linear mappings from its image in a basis.
- Calculate the kernel and the image of a linear transformation.
- Make calculations of a linear transformation in different basis. Apply the basis change matrix for these calculations.
- Perform operations of linear applications: addition, multiplication by a scalar, composition.
- Determine the eigenvalues and eigenvectors of an endomorphism.
- Use the Cayley-Hamilton theorem
- Apply the scalar product of vectors to calculate distances and angles.
- Determine orthogonality between vectors.
- Apply the orthonormalization Gram-Schmidt process in order to compute orthonormal basis.
- Reasoning and compare solutions.
- Summarising the statement of a problem to express it mathematically.
- Use mathematical techniques to solve problems.
- Reasoning and analyze the results obtained from the calculation.

- Ability to analyse and synthesize.

  Objectives

  - Discuss and solve linear systems of equations.
  - Solve systems by the method of Cramer.
  - Analyze if a set of vectors is linearly independent or not.
  - Use the Cayley-Hamilton theorem.
  - Apply the scalar product of vectors to calculate distances and angles.
  - Determine orthogonality between vectors.
  - Reasoning and compare solutions.
  - Summarising the statement of a problem to express it mathematically.
  - Reasoning and analyze the results obtained from the calculation.

Competences

EPS1. Capacity to solve problems and prepare and defence arguments inside the area of studies.

EPS5. Capacity of abstraction and of critical, logical and mathematical thinking.

EPS6. Capacity of analysis and synthesis.

GEM1. Capacity to solve mathematical problems arisen in the engineering field. Aptitude to apply knowledge on: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and in partial derivatives; numerical methods; algorithmic, numerical; statistics and optimisation.

Subject contents

1. Matrices, determinats and systems of linear equations.

1.1 Types of Matrices and operations with matrices.

1.2 Invertible matrices.

1.3 Determinant of a square matrix of order n. Cases n=2, n=3 and n>3.

1.4 Rank of a matrix.

1.5 Elementary transformations by rows. Gauss elimination method.

1.6 Expression of a system of linear equations by matrices.

1.7 Rouché-Frobenius theorem.

1.8 Cramer Systems

2. Vector spaces.

2.1 Definition, properties and examples.

2.2 Linear combination: linear dependence and linear independence.

2.3 Generating system.

2.4 Basis of a vector space: definition, dimensions, components.

2.5 Vector Subspace. Linear varieties.

2.5.1 Description by using generators and equations.

2.5.2 Gauss Transformations.

2.5.3 Basis and dimension.

2.6 Changes of basis. Basis change matrix.

2.7 Operations on subspaces.

2.7.1 Containment and equality.

2.7.2 Intersection and sum.

2.7.3 Grassman formula.

2.7.4 Complementary and direct sum.

3. Linear transformations and endomorphism diagonalization.

3.1 Definition and properties of a linear transformation.

3.2 Determination by the image in a basis.

3.3 Kernel and image of a linear transformation.

3.4 Matrix representation of a linear transformation.

3.5 Changes of basis in a linear transformation. Similar matrices.

3.6 Operations with linear applications.

3.6.1 Sum of applications.

3.6.2 Product by a scalar.

3.6.3 Composition of applications.

4. Endomorphism diagonalization.

4.1 Diagonal matrix: eigenvalues and eigenvectors.

4.2 Characteristic polynomial of an endomorphism: definition and calculation.

4.3 Cayley-Hamilton theorem.

4.4 Algebraic multiplicity.

4.5 Subspace generated by an eigenvector: geometric multiplicity.

4.6 Characterization of diagonalizable endomorphisms.

4.7 Applications of diagonalization: Powers of matrices, Linear Recurrences and Systems of linear differential equations.

5. Bilinear forms and quadratic forms.

5.1 Properties of the ordinary scalar product in Rn. Concept of bilinear form.

5.2 Matrix representation of a bilinear form in a base. Concept of orthogonality.

5.3 Symmetric bilinear form. Gauss method to find a orthogonal basis. Gram-Schmidt process of orthonormalization.

5.4 Definition of rank and signature. Effective methods of calculation of these invariants.

5.5 Scalar Products. Definition of the associated norms. Orthonormal basis. Applications to geometry.

5.6 Quadratic form associated to a bilinear form.

5.7 Applications: Expression of a quadratic form as a linear combination of squares. Classification of conics and quadrics.

Methodology

See development plan

Development plan

Activity:

Lectures: The issues described in the section Contents will be held in the master classes throughout the different weeks of class.
From: Begining of the semester until the end of the semester.

Classroom hours 28 h learning hours 42 h

Activity:
Classroom practices: The issues described in section contents is developed in practices in the classroom during the teaching weeks.
From: Begining of the semester until the end of the semester.

Classroom hours 28 h learning hours 42 h

Activity:
Tutorial: Revisions examinations and office hours serve to resolve doubts and clarify concepts.
From: Begining of the semester until the end of the semester.

Contact hours 2h hours learning hours 3h

Activity:
Evaluation: The evaluation described in paragraph Evaluation, written tests will be developed through classroom (exams) and delivery of exercises.
From: Begining of the semester until the end of the semester.

Contact hours 6h hours learning hours 8h

Evaluation

Activity: Written test Dates: Week 8 percentage: 40% Character: Compulsory Realization: Single

Criteria: Written exam - PA1 To consider the note of attendance and participation must be at least 4 (10) of PA1 and PA2.

Note: In written tests can take conventional scientific calculator. But not authorized the use of these calculators, or other device, which carry information stored or can transmit it.

Activity: Participation and Attendance Dates: 1/8 Weeks Percentatge10% Character: Compulsory Realization: Single

Criteria: To consider the note of attendance and participation must be at least 4 (10) of PA1 and PA2.

Activity: Written test: Dates: Week 17/18 Percentage: 40% Character: Compulsory Realization: Single

Criteria: Written exam - PA2 To consider the note of attendance and participation must be at least 4 (10) of PA1 and PA2.

Note: In written tests can take conventional scientific calculator. But not authorized the use of these calculators, or other device, which carry information stored or can transmit it.

Activity: Participation and Attendance Dates: 9/16 Weeks Percentatge 10% Character: Compulsory Realization: Single

Criteria: To consider the note of attendance and participation must be at least 4 (10) of PA1 and PA2.

Activity: Problems Dates: Week 16 Percentatge10% Character: Volunteer Realization: Single

Criteria: To consider the note of Problems should be at least 4 (10) of PA1 and PA2.

Bibliography

BASIC BIBLIOGRAPHY

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REVIEWING BIBLIOGRAPHY

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RECOMMENDED BIBLIOGRAPHY

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M.Castellet i I. Llerena, Àlgebra lineal i geometria., Publicacions de la UAB, Barcelona, 1988.

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E.Domínguez et al., Problemas de Álgebra Lineal, Bellisco, Madrid, 1998.

M.T.García González, A. Ruiz Oliarria, M.M. Saiz Jarabo, Álgebra. Teoría y ejercicios. Ed. Paraninfo, Madrid, 1993.

J.Gimbert i J.M. Miret, Problemes d'Àlgebra per a Ciències de la Computació. Col.lecció Eines, no. 20. Ed. de la UdL. Lleida. 1997.

S.Lang, Introducción al Álgebra Lineal. Ed. Addison-Wesley, Wilmington, Delaware,1990.

J. Rojo i I. Martín, Ejercicios y problemas de ÁlgebraLineal, Ed. Vector Ediciones, Madrid, 1989.