Universitat de Lleida

DEGREE CURRICULUM

LINEAR ALGEBRA

Academic year 2013-14

Subject's general information

Subject name	Linear Algebra
Code	101401
Semester	2n Q Avaluació Continuada
Typology	Troncal
ECTS credits	6
Theoretical credits	0
Practical credits	0
Department	Matemàtica
Important information on data processing	Consult this link for more information.
Language	Catalan
Office and hour of attention	A concretar. Despatx 1.12 de l'Escola Politècnica Superior.

Maite Grau Montaña

Subject's extra information

Suggestions

Subject that requires continuous work throughout the semester in order to achieve its goals. It requires critical thinking and capacity for abstraction. You can find collections of these materials at the Cappont Campus (Building Aulari) and the Virtual Campus: http://cv.udl.cat - Collection set of exercises with the numerical solutions. - Resolutions of exams in previous years. It is recommended to frequently visit the site at the Virtual Campus since all the information is announced there.

The course as part of the academic plan

This course is in the 2nd semester of 1st year of teaching. It belongs to the module of "Basic Training", specifically in the field "Scientific Basis".

Learning objectives

See competences

Significant competences

University of Lleida strategic competences

- Correctness in oral and written language.
  - To discuss and to solve linear systems of equations.
  - To analyze whether a set of vectors is linearly dependent.
  - To describe vector spaces and subspaces.
  - To apply Grassman formula.
  - To determine the eigenvalues and eigenvectors associated with an endomorphism and to interpret them geometrically.
  - To apply vector calculus to the geometric description of objects.
  - To classify conics and quadrics from its equation.
  - To reason and to contrast solutions.
  - To synthesize the statement of a problem in order to express it mathematically.
  - To reason and to analyze the results obtained from the calculation.

Degree-specific competences

- Aptitude to use applied knowledge tied with numeric and infinitesimal calculus, lineal algebra, analytical and differential geometry and the probabilistic and stadistical analysis probabilistic techniques and methods.
  - To operate with matrices: sum, product, transpose and inverse.
  - To make Gauss elementary transformations in order to determine the rank of a matrix.
  - To compute determinants of square matrices of any order.
  - To discuss and to solve linear systems of equations.
  - To solve systems by the method of Cramer.
  - To determine if a vector is a linear combination of a set of vectors.
  - To analyze whether a set of vectors is linearly dependent.
  - To describe vector spaces and subspaces.
  - To make vector calculations in different basis. In particular, to calculate the components of a vector in different basis. To calculate and to apply the basis change matrix.
  - To determine the dimension of a subspace.

- To perform subspace operations: intersection, sum and direct sum.
- To apply Grassman formula.
- To determine linear mappings from its image in a basis.
- To calculate the kernel and the image of a linear transformation.
- To relate the explicit expression of a linear transformation with its matricial expression.
- To make calculations of a linear transformation in different basis. To apply the basis change matrix for these calculations.
- To perform operations of linear applications: addition, multiplication by a scalar, composition.
- To determine the eigenvalues and eigenvectors associated with an endomorphism and to interpret them geometrically.
- To use Cayley - Hamilton theorem in order to study the characteristic polynomial of an endomorphism.
- To apply the usual scalar product of vectors to calculate distances and angles.
- To determine orthogonality between vectors.
- To implement the Gram-Schmidt process for orthonormalization in order to compute orthonormal basis.
- To compute volumes of cuboids by the Gram determinant.
- To identify, classify and construct matrices for orthogonal transformations in the plane and in space.
- To apply vector calculus to the geometric description of objects.
- To classify conics and quadrics from its equation.
- To calculate the invariants of a quadratic variety.
- To reason and to contrast solutions.
- To synthesize the statement of a problem in order to express it mathematically.
- To use mathematical techniques to solve problems.
- To be able to argue and analyze the results obtained from the calculation.

Degree-transversal competences

- Ability to reunite and interpret relevant data, inside an area of study, to express reasons which include reflecting upon relevant subjects of a social, scientific or ethical nature.
  - To describe vector spaces and subspaces.
  - To determine linear mappings from its image in a basis.
  - To identify, classify and construct matrices for orthogonal transformations in the plane and in space.
  - To apply vector calculus to the geometric description of objects.
  - To classify conics and quadrics from its equation.
  - To be able to argue and analyze the results obtained from the calculation.

- Ability for abstraction and critical, logical and mathematical reasoning.
  - To determine linear mappings from its image in a basis.
  - To make calculations of a linear transformation in different basis. To apply the basis change matrix for these calculations.
  - To use Cayley - Hamilton theorem in order to study the characteristic polynomial of an endomorphism.
  - To apply the usual scalar product of vectors to calculate distances and angles.
  - To reason and to contrast solutions.
  - To be able to argue and analyze the results obtained from the calculation.

- Ability to analyse and synthesise.
  - To discuss and to solve linear systems of equations.
  - To analyze whether a set of vectors is linearly dependent.
  - To identify, classify and construct matrices for orthogonal transformations in the plane and in space.
  - To classify conics and quadrics from its equation.
  - To synthesize the statement of a problem in order to express it mathematically.

- To be able to argue and analyze the results obtained from the calculation.

- Ability to resolve problems and elaborate and defend arguments inside an area of study.
  - To reason and to contrast solutions.
  - To synthesize the statement of a problem in order to express it mathematically.
  - To use mathematical techniques to solve problems.
  - To be able to argue and analyze the results obtained from the calculation.

Subject contents

1. Matrices, determinants and systems of linear equations.

1.1 Types of matrices and matrix operations.

1.2 Inversible 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 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. 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.

3.7 Diagonal matrix: eigenvalues and eigenvectors.

3.8 Characteristic polynomial of an endomorphism: definition and calculation.

3.9 Cayley-Hamilton theorem.

3.10 Algebraic multiplicity.

3.11 Subspace generated by an eigenvector: geometric multiplicity.

3.12 Characterization of diagonalizable endomorphisms.

4. Euclidean Geometry

4.1 Scalar product.

4.2 Norm induced by a scalar product.

4.3 Distances and angles.

4.4 Concepts of orthogonal and orthonormal.

4.5 Gram-Schmidt process of orthonormalization.

4.6 Gram's determinant. Volume of cuboid.

4.7 Vector Product.

4.8 Orthogonal transformations: in the plane and in space.

4.9 Isometries or rigid motions.

5. Classification of conics and quadrics.

5.1 symmetric endomorphisms and scalar product.

5.2 symmetric bilinear form.

5.3 Range and signature: definition and calculation of these invariants.

5.4 Quadratic forms.

5.5 Quadratic varieties: canonical equation.

5.6 Classification of Euclidean conics and quadrics.

5.7 Other examples of curves. Trajectories. Parametrized curves.

5.8 Homothetic transformations.

5.9 Similarities.

Methodology

Veure apartat "Pla de desenvolupament".

Development plan

Els temes descrits en l'apartat de Continguts es desenvoluparan mitjançant classes magistrals i pràctiques a l'aula al llarg de les setmanes lectives.	
Total hores presencials: 28h	Total hores no presencials: 42h

Els temes descrits en l'apartat de Continguts es desenvoluparan mitjançant classes magistrals i pràctiques a l'aula al llarg de les setmanes lectives.	
Total hores presencials: 28h	Total hores no presencials: 42h

L'avaluació, descrita en l'apartat Avaluació, es desenvoluparà mitjançant proves escrites presencials (examens) i l'entrega d'exercicis.	
Total hores presencials: 6h	Total hores no presencials: 10h

Les revisions d'examen i les hores de consulta serveixen per a resoldre dubtes i aclarir conceptes.	
Total hores presencials: 8h	Total hores no presencials: 0h

Evaluation

Prova PA1
Examen escrit (individual i obligatori)
Data: abril i segons el calendari de l'escola http://www.eps.udl.cat/info_acad/horaris_calendaris/calendari_examens.html
Percentatge de la nota final: 40%
Observació: Per a tenir en compte la nota d'exercicis cal tenir almenys un 4 (sobre 10) de PA1 i de PA2.
Objectius • Discutir i resoldre sistemes lineals d'equacions. • Analitzar si un conjunt de vectors és linealment dependent o no. • Descriure espais i subespais vectorials. • Aplicar la fòrmula de Grassman. • Raonar i contrastar solucions. • Raonar i analitzar els resultats obtinguts a partir del càlcul.

Prova PA2
Examen escrit (individual i obligatori)
Data: juny i segons el calendari de l'escola http://www.eps.udl.cat/info_acad/horaris_calendaris/calendari_examens.html
Percentatge de la nota final: 40%
Observació: Per a tenir en compte la nota d'exercicis cal tenir almenys un 4 (sobre 10) de PA1 i de PA2.
Objectius • Determinar els valors i vectors propis associats a un endomorfisme i interpretar-los geomètricament. • Aplicar el càlcul vectorial a la descripció geomètrica d'objectes. • Classificar còniques i quàdriques a partir de la seva equació. • Raonar i contrastar solucions. • Sintetitzar l'enunciat d'un problema a fi d'expressar-lo matemàticament. • Raonar i analitzar els resultats obtinguts a partir del càlcul. • Raonar i contrastar solucions. • Utilitzar les tècniques matemàtiques per a resoldre problemes.

Entrega d'exercicis
Entrega d'exercicis
Data: durant les setmanes de classes, cada setmana hi haurà una entrega. Demanda aleatòria.
Percentatge de la nota final: 20% (s'avaluen dos dels execicis entregats, cadascun amb un pes de 10% sobre la nota final)
Observació: Per a tenir en compte la nota d'exercicis cal tenir almenys un 4 (sobre 10) de PA1 i de PA2.
Objectius: Tots els de l'assignatura.

Prova de recuperació
Examen escrit (individual i voluntari)
Data: juny/juliol i segons el calendari de l'escola http://www.eps.udl.cat/info_acad/horaris_calendaris/calendari_examens.html
Percentatge de la nota final: 80%
Observacions: El contingut d'aquesta prova són **tots els temes** de l'assignatura. Per a tenir en compte la nota d'exercicis cal tenir almenys un 4 (sobre 10) d'aquesta prova recuperatòria. Tots els alumnes es poden presentar a aquesta prova per a recuperar/millorar nota.
Objectius: Tots els de l'assignatura.

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