310601 - Algebra

Coordinating unit: 310 - EPSEB - Barcelona School of Building Construction
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2018
Degree: BACHELOR'S DEGREE IN GEOINFORMATION AND GEOMATICS ENGINEERING (Syllabus 2016).
(Teaching unit Compulsory)
ECTS credits: 6  Teaching languages: Catalan, English

Teaching staff

Coordinator: JUAN RODRIGUEZ JORDANA
Others: JUAN RODRIGUEZ JORDANA

Prior skills

High school math curriculum.

Requirements

As a subject of the semester 1A, there are no requirements.

Degree competences to which the subject contributes

Specific:
1. Capacity for the resolution of mathematic problems that can be set out in engineering. Aptitude to apply the knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and in partial derivates, numeric methods, numeric algorithm, statistics and optimization.

2. (ENG) Determinar, mesurar, avaluar i representar el terreny, objectes tridimensionals, punts i trajectòries.

3. (ENG) Planificació, projecte, direcció, execució i gestió de processos de mesura, sistemes d'informació, explotació d'imatges, posicionament i navegació; modelització, representació i visualització de la informació territorial en, sota i sobre la superfície terrestre.

Transversal:
5. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

Teaching methodology

It will be used the following methodology:
Expositive method for the content strictly theoretical.
Espositive-participatory for the majority of the units.
Resolution of exercises and problems
Practices in the calculus laboratory

Learning objectives of the subject

At the end of the subject, the student must be capable of:
Describe the basic elements of Linear Algebra related to the vectorial spaces and linear applications and explain its principal characteristics.
Classify and solve systems of determinated, indeterminated and over-determinated linear equations.
Describe and use geometric transformations and changes with the referent systems.
Define and classify quadratic, form and quadric forms.
Define, enumerate the principal properties and resolve flat and esferic triangles.

<table>
<thead>
<tr>
<th>Study load</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong></td>
<td>150h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours large group:</td>
<td>24h</td>
<td>16.00%</td>
<td></td>
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<tr>
<td>Hours medium group:</td>
<td>36h</td>
<td>24.00%</td>
<td></td>
</tr>
<tr>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
<td></td>
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</tbody>
</table>
# Content

## C1 Vector Spaces

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>25h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes</td>
<td>5h</td>
</tr>
<tr>
<td>Practical classes</td>
<td>2h 30m</td>
</tr>
<tr>
<td>Laboratory classes</td>
<td>2h 30m</td>
</tr>
<tr>
<td>Guided activities</td>
<td>0h</td>
</tr>
<tr>
<td>Self study</td>
<td>15h</td>
</tr>
</tbody>
</table>

### Description:
In this content the following topics will be developed:
- Operations between scales and vectors.
- Linear independence. Bases and dimension.
- Matrix and determinant
- Euclidean space. Scalar product

### Related activities:
- Theory classes
- Problem classes
- Laboratory practices of calculus with Maple. Activity L1
- Practice exam of questions. Activity Q1
- Theoretical exam test type. Activity T1

### Specific objectives:
At the end of the content, the student must be capable of:
- Enumerate the operations between scalars and vectors and their properties.
- Recognise if a system of vectors is independent or dependent.
- Know the most important properties of matrices and determinants.
# C2 Linear Transformations

<table>
<thead>
<tr>
<th>Learning time: 30h</th>
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</thead>
<tbody>
<tr>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>Practical classes: 3h</td>
</tr>
<tr>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td>Self study: 18h</td>
</tr>
</tbody>
</table>

## Description:
In this content the following topics are developed:
- Recognize if a function is a linear transformation or not
- Linear transformation of a matrix
- Geometric interpretation of the linear transformations of 2 and 3 variables
- Change of base
- Invariant directions and diagonal form of a transformation.

## Related activities:
- Theory classes
- Problem classes
- Laboratory practices of calculus with Maple. Activity L2
- Practice exam of questions. Activity Q1
- Theoretical exam test type. Activity T1

## Specific objectives:
At the end of the content, the student must be capable of:
- Recognize if a function is a linear transformation or not and, in the case is not, express the in matrix
- Interpretate geometrically the linear transformations of 2 and 3 variables
- Express a plane and a straight line in the 3D space and resolve incidence problems
- Define and calculate the invariant directions and the diagonal form of a transformation.
### C3 Numerical Solution of Linear Systems

**Learning time:** 25h  
- Theory classes: 5h  
- Practical classes: 2h 30m  
- Laboratory classes: 2h 30m  
- Self study: 15h

**Description:**  
In this content the following topics are developed:  
- Decomposition LU  
- Decomposition QR  
- Resolution of linear determined, undetermined and overdetermined equation systems

**Related activities:**  
- Theory classes  
- Problem classes  
- Laboratory practices of calculus with Maple. Activity L3  
- Practice exam of questions. Activity Q2  
- Theoretical exam test type. Activity T2

**Specific objectives:**  
At the end of the content, the student must be capable of:  
- Do the decomposition LU, in a square matrix and resolve the certain systems by this decomposition  
- Resolve overcertain systems according to the criteria of minimum squares and the system of normal equations  
- Do the decomposition QR of a matrix and resolve overdetermined according to this decomposition.
### C4 Change of Reference Systems

<table>
<thead>
<tr>
<th>Learning time: 25h</th>
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</thead>
<tbody>
<tr>
<td>Theory classes: 5h</td>
</tr>
<tr>
<td>Practical classes: 2h 30m</td>
</tr>
<tr>
<td>Laboratory classes: 2h 30m</td>
</tr>
<tr>
<td>Guided activities: 0h</td>
</tr>
<tr>
<td>Self study: 15h</td>
</tr>
</tbody>
</table>

**Description:**  
At the end of this content the following topics will be developed:  
- Similarity transformations  
- Related transformations  
- Bilinear transformations  
- Projective transformations. Colinearity equation  
- Coplanarity equation

**Related activities:**  
- Theory classes  
- Problem classes  
- Laboratory practices of calculus with Maple. Activity L3  
- Practice exam of questions. Activity Q2  
- Theoretical exam test type. Activity T2

**Specific objectives:**  
At the end of the content, the student must be capable of:  
- Define, recognise and express a similarity transformation and estimate their parameters  
- Define, recognise and express related transformations and estimate their parameters  
- Define, recognise and express a bilinear transformation and estimate their parameters  
- Define, recognise and express projective transformations and estimate their parameters  
- Define, recognise and express a colinearity equation  
- Define, recognise and express a coplanarity equation
C5 Quadratic Forms

Learning time: 20h
Theory classes: 4h
Practical classes: 2h
Laboratory classes: 2h
Guided activities: 0h
Self study: 12h

Description:
In this content the following topics will be developed:
- Tensors
- Quadratic forms
- Conics
- Quadric

Related activities:
- Theory classes
- Problem classes
- Laboratory practices of calculus with Maple. Activity L4
- Practice exam of questions. Activity Q2
- Theoretical exam test type. Activity T2

Specific objectives:
- At the end of the content, the student must be capable of:
  - Define tensor and quadratic form
  - Express the matrix form and the change of base
  - Calculate the the reduced form
  - Classify a quadratic form
  - Define conic and quadric, express and analyze them in their reduced form
  - Do transformations of coordinates in the equations of a conic and a quadric
# C6 Spherical Trigonometry

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 20h</th>
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</thead>
<tbody>
<tr>
<td>In this content the following topics will be developed:</td>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td>Spherical triangles</td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>Resolution of spherical triangles</td>
<td>Laboratory classes: 2h</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Related activities:</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Theory classes</td>
<td>Guided activities: 0h</td>
</tr>
<tr>
<td>Problem classes</td>
<td>Self study : 12h</td>
</tr>
<tr>
<td>Laboratory practices of calculus with Maple. Activity L4</td>
<td></td>
</tr>
<tr>
<td>Practice exam of questions. Activity Q2</td>
<td></td>
</tr>
<tr>
<td>Theoretical exam test type. Activity T2</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific objectives:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>At the end of the content, the student must be capable of:</td>
<td></td>
</tr>
<tr>
<td>Define spherical triangle and enumerate the main properties</td>
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<tr>
<td>Resolve spherical triangles</td>
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</tbody>
</table>
**Planning of activities**

<table>
<thead>
<tr>
<th></th>
<th>Hours: 2h</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>Laboratory classes: 2h</td>
</tr>
</tbody>
</table>

**Description:**
Practice with Maple. The language of this activity will be English

**Support materials:**
Maple

**Descriptions of the assignments due and their relation to the assessment:**
The practice with Maple support

**Specific objectives:**
At the end of the practice the student must be capable of doing operations with vectors and matrices, resolve linear systems, and work with the scalar and vectorial product with Maple

<table>
<thead>
<tr>
<th></th>
<th>Hours: 2h</th>
</tr>
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<tbody>
<tr>
<td>L2</td>
<td>Laboratory classes: 2h</td>
</tr>
</tbody>
</table>

**Description:**
Practice with Maple. The language of this activity will be English

**Support materials:**
Maple

**Descriptions of the assignments due and their relation to the assessment:**
Test with questions about the practice

**Specific objectives:**
At the end of this practice the student must be capable of defining a linear transformation, do base changes and diagonalize matrix with Maple

<table>
<thead>
<tr>
<th></th>
<th>Hours: 2h</th>
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</thead>
<tbody>
<tr>
<td>L3</td>
<td>Laboratory classes: 2h</td>
</tr>
</tbody>
</table>

**Description:**
Practice with Maple. The language of this activity will be English

**Support materials:**
Maple

**Descriptions of the assignments due and their relation to the assessment:**
The practice with Maple support

**Specific objectives:**
At the end of this practice the student must be capable of resolving definite linear systems and overdefinite by decompositions LU and QR, define and estimate the parameters of a coordinate parameters with Maple

<table>
<thead>
<tr>
<th></th>
<th>Hours: 2h</th>
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</thead>
<tbody>
<tr>
<td>L4</td>
<td>Laboratory classes: 2h</td>
</tr>
</tbody>
</table>
### Description:
Practice with Maple. The language of this activity will be English

### Support materials:
Maple

### Descriptions of the assignments due and their relation to the assessment:
The practice with Maple support

### Specific objectives:
At the end of this practice, the student must be capable of working with transformations of coordinates applied to conics and quadrics using the Maple program

| T1 | Hours: 0h 30m  
|    | Theory classes: 0h 30m |

- **Description:** Test
- **Support materials:** Questions of test
- **Specific objectives:** At the end of this activity, the student must be capable of verifying the grade of achievement of the theoretical concepts related to the contents 1 and 2

| T2 | Hours: 0h 30m  
|    | Theory classes: 0h 30m |

- **Description:** Test
- **Support materials:** Test questions
- **Specific objectives:** At the end of this activity, the student must be capable of verifying the grade of achievement of the theoretical concepts related to the contents 3 to 6

| (ENG) Q1 | Hours: 1h 30m  
|          | Theory classes: 1h 30m |

- **Description:** Question test
- **Support materials:** Wording
Descriptions of the assignments due and their relation to the assessment:
Questions answered

Specific objectives:
At the end of this activity, the student must be capable of verifying the grade of achievement of the practical concepts and mechanisms related to the contents 1 and 2

(ENG) Q2

Description:
Question test

Support materials:
Wording

Descriptions of the assignments due and their relation to the assessment:
Questions answered

Specific objectives:
At the end of this activity, the student must be capable of verifying the grade of achievement of the practical concepts and mechanisms related to the contents 3 to 6

Generic Competence 3rd Language

Description:
With the goal of developing the competence in 3rd language, the practices with the Maple support will be done in English

Qualification system

Contents 1 and 2
An exam with questions and a theory test: 35% of the final mark
Two practices at the calculus laboratory: 2.5% of the final mark each one

Contents from 3 to 6
An exam with questions and a theory test: 35% of the final mark
Two practices at the calculus laboratory: 2.5% of the final mark each one

It will be valued the attendance in class with a 20% of the final mark

Each one of the two exams with questions and theory test will be object of re-evaluation. In case of surpassing the mark obtained in the previous exam, the final mark will be re-calculated with the same distribution.
Regulations for carrying out activities

The exams of questions and theory tests corresponding to the contents 1 and 2 will be made during the period of exams in the middle of the four-month period. The exams of questions and theory tests corresponding to the contents from 3 to 6 will be made during the period of exams at the end of the four-month period. The practices will be made, approximately, during the 3rd, 7th, 12th and 15th week of class. Each one of the two exams with questions and theory test will be object of re-evaluation during the period established for the centre. In case of surpassing the mark obtained in the previous exam, the final mark will be re-calculated with the same distribution.

Bibliography

Basic:


Complementary:


Others resources:

The subject has a course at the virtual campus ATENEA where may be found:
A link to the teacher's guide
A PDF file where will be keep track of the activities developed
A repository of practices to solve
A repository of settled practices
A repository of solved exercises
A solved repository of exams
A repository of tasks to perform
The grades of the different evaluable tests.