250201 - ALGLIN - Linear Algebra

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2018
Degree: BACHELOR'S DEGREE IN PUBLIC WORKS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 6

Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: NAPOLEON ANENTO MORENO
Others: NAPOLEON ANENTO MORENO, MARIA ANGELES PUIGVI BURNIOL

Opening hours
Timetable: Hours to be arranged with faculty.

Degree competences to which the subject contributes

Specific:
3096. Ability to solve the types of mathematical problems that may arise in engineering. Ability to apply knowledge of: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial derivatives; numerical methods; numerical algorithms; statistics and optimisation.

Transversal:
591. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.
597. EFFECTIVE USE OF INFORMATION RESOURCES - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.
600. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.

Teaching methodology

The course consists of 4 hours per week of classroom activity (large size group).

The 4 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

Learning objectives of the subject

Students will acquire a general understanding of linear algebra, methods for solving linear problems encountered in engineering, and key aspects of analytical geometry. They will also acquire the skills to solve mathematical problems encountered in engineering that involve these concepts.

On completion of the course, students will have acquired the ability to:
1. Interpret vector spaces;
2. Solve linear equation systems manually and using basic software;
3. Produce geometric interpretations of concepts in vector calculus.


### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Theory classes: 30h 30m, 20.33%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 17h 30m, 11.67%</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 12h, 8.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 6h, 4.00%</td>
</tr>
<tr>
<td></td>
<td>Self study: 84h, 56.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Learning time: 21h 36m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 7h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study : 12h 36m</td>
</tr>
</tbody>
</table>

### 1. Vector Space

**Description:**
- Basic problems.
- Rank of a system of vectors. Sum and intersection.
- Direct sum. Grassmann.

### 2. Matrices

**Description:**
- Inverse matrix. Gauss-Jordan method.

### 3. Determinant

**Description:**
- Definition. Basic properties.
- Calculation of a determinant.
- Row/column operations.
- Invertibility and determinant. Cofactor expansion. Examples.
- Row/columns operations: general properties.
### 4. System of linear equations

**Learning time:** 8h 24m  
Theory classes: 2h 30m  
Practical classes: 1h  
Self study: 4h 54m

**Description:**  
Definition and types. Augmented matrix.  
Row operation. Equivalent systems.  
Rouché-Frobenius theorem.  
Gauss-Jordan Reduction. Cramer’s rule.  
Linear Systems. Exercises.

### 5. Linear Transformation

**Learning time:** 21h 36m  
Theory classes: 3h  
Practical classes: 2h  
Laboratory classes: 4h  
Self study: 12h 36m

**Description:**  
Definition and classification. Range Space and Null Space.  
Change of Basis.  
Linear Transformation. Exercises.

### 6. Homomorphism

**Learning time:** 16h 48m  
Theory classes: 3h  
Practical classes: 4h  
Self study: 9h 48m

**Description:**  
Eigenvalues and eigenvectors.  
Cayley-Hamilton theorem.  
Homomorphisms. Exercises.  
Exercises. Diagonalizability.  
Cayley-Hamilton theorem.
## 7. Inner Product Space

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>32h 24m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>5h</td>
</tr>
<tr>
<td>Practical classes:</td>
<td>3h 30m</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>5h</td>
</tr>
<tr>
<td>Self study:</td>
<td>18h 54m</td>
</tr>
</tbody>
</table>

**Description:**


Basic properties

Basic exercises.

## 8. Affine Geometry

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>18h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>3h</td>
</tr>
<tr>
<td>Practical classes:</td>
<td>1h 30m</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>3h</td>
</tr>
<tr>
<td>Self study:</td>
<td>10h 30m</td>
</tr>
</tbody>
</table>

**Description:**

Affinities

Exercises. General properties.
Qualification system

The final grade is obtained from partial qualifications follows:

E0: Continuous assessment activities
E1: Test of the units developed on the first half of the term
E2: Test of the units developed on the second half of the term
E3: Global test of the course

The student has to choose whether to take test E2 or E3.

NF1 = 0.3E0 + 0.35E1 + 0.35E2
NF2 = 0.3E0 + 0.7E3

Final Mark = max {NF1, NF2}

The exams consist of a part with questions on concepts associated with learning objectives in terms of subject knowledge or understanding, application and a set of exercises.

Criteria for re-evaluation qualification and eligibility: Students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

Regulations for carrying out activities

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

Bibliography

Basic:


Complementary: