295909 - GD - Geometry for Design

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2018
Degree: BACHELOR’S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR’S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR’S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR’S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR’S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: Catalan

Teaching staff
Coordinator: Trias Pairó, Joan
Claverol Aguas, Mercè
Others: Trias Pairó, Joan
Claverol Aguas, Mercè

Opening hours
Timetable: To be determined by each teacher when the course starts.

Prior skills
Knowledge of basic techniques of calculus (in one and several variables) and algebra to operate with vectors and matrices.

Requirements
Pre-requisites: Calculus (CAL) and Algebra and Multivariate Calculus (ACM).

Degree competences to which the subject contributes

Specific:
CEB-01. Solve mathematical problems that may arise in engineering. Apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation.
CEB-05. Understand spatial vision and graphic representation techniques, whether using traditional metric and descriptive geometry methods or computer assisted design applications.
CEMEC-19. Understand and apply graphic engineering techniques.

Generical:
CG-03. (ENG) Conocimiento en materias básicas y tecnológicas, que les capacite para el aprendizaje de nuevos métodos y teorías y les dote de versatilidad para adaptarse a nuevas situaciones.

Transversal:
07 AAT N1. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
07 AAT N2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
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Teaching methodology

In theory and problem classes, the teacher will use an expository methodology with illustrative examples. It will also guide students in the resolution of related exercises. In the laboratory classes will be made graphic practices to deepen the concepts and techniques presented in the theoretical classes.

Learning objectives of the subject

To know how to use coordinate systems changes to solve geometric problems.
To be able to construct orthonormal basis for geometric construction and parameterization of curves and surfaces.
To know the most used curves and surfaces in geometry, and to know methods for generation of surfaces.
To become acquainted with affine geometric transforms in the plane, and how to use them.
To know and to be able to use affine geometric transforms in the space.
To know and to be able to design the most used curves in computer aided graphic design: Bézier curves, B-splines, rational Bézier curves and NURBS.
To know basic concepts of differential geometry of curves: curvature, torsion, osculating circle, Frenet trihedral, offset curves.
To know basic concepts of differential geometry of surfaces: tangent plane, normal vector, Dupin indicatrix.
To know how to deal with the problem of geometric continuity in curves and Bézier surfaces.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 30h</th>
<th>20.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours small group: 30h</td>
<td>20.00%</td>
</tr>
<tr>
<td></td>
<td>Self study: 90h</td>
<td>60.00%</td>
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### Content

<table>
<thead>
<tr>
<th>Coordinate Systems</th>
<th>Learning time: 2h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
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</table>

**Description:**

<table>
<thead>
<tr>
<th>Curves and Surfaces</th>
<th>Learning time: 3h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
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**Description:**

<table>
<thead>
<tr>
<th>Metric Problems</th>
<th>Learning time: 3h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
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</table>

**Description:**

<table>
<thead>
<tr>
<th>Plane Affine Geometric Transforms</th>
<th>Learning time: 3h</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
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</tbody>
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**Description:**
### Three-dimensional Affine Geometric Transforms

**Learning time:** 4h  
**Theory classes:** 4h

**Description:**  

### Bézier and B-splines curves

**Learning time:** 4h  
**Theory classes:** 4h

**Description:**  

### Differential geometry of curves

**Learning time:** 2h  
**Theory classes:** 2h

**Description:**  

### Rational Curves, NURBS

**Learning time:** 4h  
**Theory classes:** 4h

**Description:**  

### Differential geometry of surfaces

**Learning time:** 3h  
**Theory classes:** 3h

**Description:**  
The Grade is calculated through continuous assessment through the presentation of exercises, laboratory tasks and a realization of a test.

Part 1. Exercises: 15%, Laboratory tasks: 25%, Test: 10%
Part 2. Exercises: 15%, Laboratory tasks: 25%, Test: 10%

Bibliography

Basic:

Complementary:

Others resources:
- http://www-history.mcs.st-andrews.ac.uk/Curves/Curves
- http://geometrie.foretnik.net/files/NURBS-en.swf