Course guide
295909 - GD - Geometry for Design

Unit in charge: Barcelona East School of Engineering
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR’S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR’S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR’S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR’S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR’S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2023  ECTS Credits: 6.0  Languages: Catalan

LECTURER

Coordinating lecturer: Claverol Aguas, Mercè
Others: Claverol Aguas, Mercè

PRIOR SKILLS

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

REQUIREMENTS

Pre-requirements: 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.

General:
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.

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, amb 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.
To know basic structures of computational geometry: Voronoi diagrams and Delaunay triangulations.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Hours small group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Self study</td>
<td>90,0</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>30.0</td>
<td>20.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

CONTENTS

Introduction: Rendering of basic geometric elements

Description:

Related activities:
Practice 1, Test 1

Full-or-part-time: 2h
Theory classes: 2h

Affine geometry. Barycentric coordinates

Description:
Description of affine geometry. Combinations of points and convex hull. Barycentric coordinates. Ratio of aligned points.

Related activities:
Practice 2, Test 1

Full-or-part-time: 2h
Theory classes: 2h
### Plane Affine Geometric Transforms

**Description:**

**Specific objectives:**
Practice 3, Test 1

**Full-or-part-time:** 2h  
Theory classes: 2h

### Three-dimensional Affine Geometric Transforms

**Description:**

**Specific objectives:**
Practice 3, Test 1

**Full-or-part-time:** 2h  
Theory classes: 2h

### Euclidean geometry. Metric Problems

**Description:**

**Related activities:**
Practice 4. Test 1

**Full-or-part-time:** 2h  
Theory classes: 2h

### Bézier and B-splines curves

**Description:**
Bézier curves: definition, De Casteljau's Algorithm, properties, operations and geometric continuity. B-splines curves.

**Related activities:**
Practices 5 and 8. Test 1

**Full-or-part-time:** 5h  
Theory classes: 5h
Differential geometry of curves

Description:

Related activities:
Practice 6, Test 2

Full-or-part-time: 4h
Theory classes: 4h

Rational Curves, NURBS

Description:

Related activities:
Practices 7 and 8. Test 2

Full-or-part-time: 5h
Theory classes: 5h

Differential geometry of surfaces

Description:

Related activities:
Practice 9, Test 2

Full-or-part-time: 4h
Theory classes: 4h

Computational Geometry: Voronoi diagrams and Delaunay triangulations

Description:
Introduction to basic structures in computational geometry with applications in engineering and design: Voronoi diagram and Delaunay triangulation. Farthest Voronoi diagram. Higher-order Voronoi diagrams.

Related activities:
Practice 10, Test 2

Full-or-part-time: 2h
Theory classes: 2h

GRADING SYSTEM

The Grade is calculated through continuous assessment through the presentation of exercises, laboratory tasks and a realization of two tests.
Exercises: 30%, Laboratory tasks: 50%, Test: 20%
BIBLIOGRAPHY

Basic:

Complementary:

RESOURCES

Other resources:
http://www.mathcurve.com/courbes3d/courbes3d.shtml
http://www-history.mcs.st-andrews.ac.uk/Curves/Curves