Course guide
340070 - MADI-D2O43 - Mathematics for Design

Last modified: 29/01/2024

Unit in charge: Vilanova i la Geltrú School of Engineering
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Antonijuan Rull, Josefina

Others: Ybern Carballo, Neus
Alcalá Vicente, Míriam

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. G1. Ability to solve arithmetic problems related to engineering. Aptitude to apply knowledge concerning: linear algebra, geometry, differential geometry, differential and integral calculus, numerical methods, stadistics technology.
D28. D28. Knowledge of ANIMACION and basic 3D simulation.
D33. D33. Knowledge of aesthetics.
D48. D48. Ability to know and apply creative process and its organization.

Transversal:
2. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.
4. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.
05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

TEACHING METHODOLOGY

There are large group classes, that deal with theoretical explanations, descriptions of selected examples and problem solving (by hand, with computer and smartphone). In the computer lab sessions, students work with Geogebra in order to work the theoretical concepts and prepare graphical projects.

LEARNING OBJECTIVES OF THE SUBJECT

* To understand the concepts and techniques of classical geometry that are essential for CAGD:
- To use affine coordinates and transformations to move and transform the shape of plane and spacial geometric figures
- To handle with conics and quadric surfaces, as exemple of basic curves and surfaces
- To understand the basicconcepts of differential geometry: curvature, torsion and osculating circle of a curve; tangent plane, normal vector of a surface.

* To use the techniques of Bézier designing curves and surfaces:
- To deal with Bernstein polynomials for Bézier curves and surfaces
- To learn the de Casteljau Algorithm
- To understand the problem of geometric continuity for Bézier curves and surfaces

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours small group	15,0	10.00
Hours large group	45,0	30.00

Total learning time: 150 h

CONTENTS

1. Affine maps

Description:
1. Affine combinations. Barycentric coordinates
2. Plane transformations
3. Mosaics
4. Space transformations

Related activities:
Activities 1,2,3,4

Related competencies :
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Full-or-part-time: 16h
Theory classes: 6h
Laboratory classes: 2h
Self study : 8h

2. Differential Geometry of curves

Description:
1 Regular parametrizations
2 Conics
3 Curvature and torsion
4 Osculating circle and evolutes
5 Frenet frame
6 Geometric continuity

Related activities:
Activities 1, 4

Related competencies :
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Full-or-part-time: 24h
Theory classes: 8h
Laboratory classes: 4h
Self study : 12h

3. Bézier curves

Description:
1 Definition and basic properties
2 Casteljau's algorithm
3 Subdivision
4 Geometric continuity

Related activities:
Activities 2, 4

Related competencies :
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Full-or-part-time: 20h
Theory classes: 8h
Laboratory classes: 2h
Self study : 10h

4. Differential Geometry of surfaces

Description:
1. Regular parameterizations
2. Quadric surfaces
3. Tangent plane
4. Offset surfaces
5. Surfaces of revolution
6. Rules surfaces
7. Tubular surfaces
4. Ruled surfaces

Related activities:
Activities 3,4

Related competencies :
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. D33. Knowledge of aesthetics.
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Full-or-part-time: 16h
Theory classes: 6h
Laboratory classes: 2h
Self study : 8h

5. Bézier Surfaces

Description:
1. Definition and properties
2. Casteljau algorithm
3. Subdivision
4. Geometric continuity
5. Coon's patches

Related activities:
Activities 3, 4

Related competencies :
. G1. Ability to solve arithmetic problems related to engineering. Aptitude to apply knowledge concerning: linear algebra, geometry, differential geometry, differential and integral calculus, numerical methods, stadistics technology.
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Full-or-part-time: 20h
Theory classes: 8h
Laboratory classes: 2h
Self study : 10h

GRADING SYSTEM

The ongoing assessment consists of three projects (activities 1, 2, 3), the practice assessment and the final exam (activity 4) with the following weights: activity 1 (20%), activity 2 (20%), activity 3 (25%), activity 4 (25%), practices (10%).

Final exam is reassessable

EXAMINATION RULES.

Activities 1, 2 and 3 are done in pairs, and must be delivered in the dates fixed at the beginning of the course. Activity 4 is a standard exam.

BIBLIOGRAPHY

Basic:

- Farin, Gerald E. Curves and surfaces for computer aided geometric design : a practical guide [on line]. 5th ed. San Francisco [etc.]: Morgan Kaufmann, 2002 [Consultation: 20/02/2024]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9781558607378/curves-and-surfaces-for-cagd. ISBN 1558607374.
- Cordero Valle, Juan Manuel; Cortés Parejo, José. Curvas y superficies para modelado geométrico. Madrid: RA-MA, 2002. ISBN 8478975314.
- Trias Pairó, Joan. Geometria per a la informàtica gràfica i CAD [on line]. Barcelona: Edicions UPC, 1999 [Consultation: 22/03/2022]. Available on: https://upcommons.upc.edu/handle/2099.3/36243. ISBN 8483013541.

Complementary:

- Boehm, Wolfgang; Prautzsch, Hartmut. Geometric concepts for geometric design [on line]. Wellesley, Mass: A.K. Peters, 1994 [Consultation: 20/02/2024]. Available on: https://www-taylorfrancis-com.recursos.biblioteca.upc.edu/books/mono/10.1201/9781315275475/geometric-concepts-geometric-design-hartmut-prautzsch-wolfgang-boehm. ISBN 1568810040.
- Gallier, Jean H. Geometric methods and applications : for computer science and engineering [on line]. New Yok [etc.]: Springer, 2011 [Consultation: 22/03/2022]. Available on: https://link.springer.com/book/10.1007/978-1-4419-9961-0. ISBN 9781441999603.
- Hoschek, Josef; Lasser, Dieter. Fundamentals of computer aided geometric design. Wellesley, Massachusetts: A. K. Peters, 1993. ISBN 1568810075.
- Marsh, Duncan. Applied geometry for computer graphics and CAD [on line]. 2nd ed. London [etc.]: Springer, 2005 [Consultation: 03/05/2022]. Available on: https://link.springer.com/book/10.1007/b138823. ISBN 1852338016.
- Trias Pairó, Joan. Laboratori de geometria computacional [on line]. Barcelona: Edicions UPC, 2005 [Consultation: 25/03/2022]. Available on: https://upcommons.upc.edu/handle/2117/166489. ISBN 8483018268.

RESOURCES

Other resources:

Geogebra (https://www.geogebra.org/) />Geogebra book of the course (https://www.geogebra.org/m/ewh6xch8) />