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340070 - MADI-D2O43 - Mathematics for Design

Coordinating unit: 340 - EPSEVG - Vilanova i la Geltrú School of Engineering

Teaching unit: 749 - MAT - Department of Mathematics

Academic year: 2018

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

ECTS credits: 6 Teaching languages: Catalan

Teaching staff

Coordinator: Jordi Guàrdia

Others: Josefina Antonijuan, Jordi Guàrdia, Imma Massana

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 following concepts of differential geometry: curvature, torsion and osculating circle of a curve; tangent plane, normal vector and Dupin indicatrix of a surface

* To use the techniques of Bézier designing curves and surfaces:

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- 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

Total learning time: 150h	Hours large group:	45h	30.00%
	Hours medium group:	0h	0.00%
	Hours small group:	15h	10.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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Content

1. Review of basic geometry

Learning time: 8h

Theory classes: 2h
Laboratory classes: 2h
Self study : 4h

Description:
1 Plane geometry: parallelism, perpendicularitu, distance
2 Space geometry: lines, planes, parallelism, perpendicularitu, distance

Related activities:
Activities 1, 2, 3, 4 & 6

2. Differential Geometry of curves

Learning time: 36h

Theory classes: 10h
Laboratory classes: 2h
Self study : 24h

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, 6

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3. Differential Geometry of Surfaces	Learning time: 24h Theory classes: 6h Laboratory classes: 2h Self study : 16h

Description:
1 Regular parameterizations
2 Cuádricas
3 Surfaces of revolution
4 Ruled surfaces
5 Tangent plane
6 Gaussian, normal and mean curvature
7 Dupin's indicatrix
8 Offset surfaces
9 Tubular surfaces

Related activities:
Activities 2,6

4. Affine maps	Learning time: 20h Theory classes: 6h Laboratory classes: 2h Self study : 12h

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

Related activities:
Activities 3,6

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5. Bézier curves	Learning time: 32h Theory classes: 10h Laboratory classes: 2h Self study : 20h

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

Related activities:
Activities 4,6

6. Bezier Surfaces	Learning time: 20h Theory classes: 6h Laboratory classes: 2h Self study : 12h

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

Related activities:
Activities 5,6

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Planning of activities

1. PROJECT 1: Differential Geometry of curves	Hours: 4h Laboratory classes: 2h Self study: 2h
Description: Desing of a roller coaster with Geogebra	

2. PROJECT 2: Differential Geometry of Surfaces	Hours: 4h Laboratory classes: 2h Self study: 2h
Description: Moving an object on a surface with Geogebra	

3. PROJECT 3: Mosaics	Hours: 6h Laboratory classes: 2h Self study: 4h
Description: Design of a mosaic with Geogebra	

4. PROJECT 4: Animation	Hours: 12h Laboratory classes: 2h Self study: 10h
Description: Design of an animation with Geogebra	

5. PROJECT 5: Composition 3D	Hours: 8h Laboratory classes: 2h Self study: 6h
Description: Design of a composition 3D with Geogebra	

6. FINAL EXAM	Hours: 2h Theory classes: 2h
Description: Exam: Problems and theoretical questions of topics 1, 2, 3 4, 5 and 6	

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Qualification system

Ongoing assessment (OA): 0.15*NA1+0.15*NA2+0.15*NA3+0.3*NA4+0.25 NA5
NA1, NA2, NA3, NA4, NA5: Projects (activities 1, 2, 3, 4,5)
NA6: Final exam (activity 6)
Final assessment: max(OA, 0.3*OA+0.7*NA6)

Final exam is re-evaluable

Regulations for carrying out activities

Activities 1, 2, 3, 4 and 5 are done in pairs, and must be delivered in the dates fixed at the beginning of the course.
Activity 6 is a standard exam.

Bibliography

Basic:

Trias Pairó, Joan. Geometria per a la informàtica gràfica i CAD [on line]. Barcelona: Edicions UPC, 1999 [Consultation: 06/11/2012]. Available on: <http://hdl.handle.net/2099.3/36243>. ISBN 8483013541.

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: 06/11/2012]. Available on: <http://www.sciencedirect.com/science/book/9781558607378>. ISBN 1558607374.

Cordero Valle, Juan Manuel; Cortés Parejo, José. Curvas y superficies para modelado geométrico. Madrid: RA-MA, 2002. ISBN 8478975314.

Complementary:

Boehm, Wolfgang; Prautzsch, Hartmut. Geometric concepts for geometric design. Wellesley, Mass: A.K. Peters, 1994. ISBN 1568810040.

Gallier, Jean H. Geometric methods and applications : for computer science and engineering. New Yok [etc.]: Springer-Verlag, 2001. ISBN 0387950443.

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: 06/11/2012]. Available on: <http://dx.doi.org/10.1007/b138823>. ISBN 1852338016.

Trias Pairó, Joan. Laboratori de geometria computacional. Barcelona: Edicions UPC, 2005. ISBN 8483018268.

Others resources:

Geogebra (https://www.geogebra.org/)
Geogebra page of the course (https://www.geogebra.org/m/da8xm4JG)