Course guide
270621 - GTCG - Geometric Tools for Computer Graphics

Last modified: 13/07/2022

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

Degree: MASTER'S DEGREE IN INNOVATION AND RESEARCH IN INFORMATICS (Syllabus 2012). (Optional subject).

Academic year: 2022 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: MERCÈ MORA GINÉ

Others: Primer quadrimestre:
MERCÈ MORA GINÉ - 10
RODRIGO IGNACIO SILVEIRA ISOBA - 10

PRIOR SKILLS

Linear Algebra

Need to refresh it?

- Here is an elementary textbook:
H. Anton, C. Rorres. Elementary linear algebra with supplemental applications: international student version. Wiley, 2011.
http://cataleg.upc.edu/record=b1341789

- And here is an basic tutorial notebook for Mathematica:
http://www.farinhansford.com/books/pla/downloads.html

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEC2. Capacity for mathematical modelling, calculation and experimental design in engineering technology centres and business, particularly in research and innovation in all areas of Computer Science.
CEE1.1. Capability to understand and know how to apply current and future technologies for the design and evaluation of interactive graphic applications in three dimensions, either when priorizing image quality or when priorizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.

Generical:
CG3. Capacity for mathematical modeling, calculation and experimental designing in technology and companies engineering centers, particularly in research and innovation in all areas of Computer Science.
CG5. Capability to apply innovative solutions and make progress in the knowledge to exploit the new paradigms of computing, particularly in distributed environments.

Transversal:
CTR6. REASONING: Capacity for critical, logical and mathematical reasoning. Capability to solve problems in their area of study. Capacity for abstraction: the capability to create and use models that reflect real situations. Capability to design and implement simple experiments, and analyze and interpret their results. Capacity for analysis, synthesis and evaluation.

Basic:
CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.

TEACHING METHODOLOGY

There will be theory classes, problems solving classes, and laboratory classes. Theory classes are aimed at presenting and discussing the geometric techniques included in the syllabus. These classes will be mainly conducted by the instructor. Problems solving and laboratory classes are aimed at consolidating the knowledge acquired and its specific application. In these classes, students will present, discuss (problems) and implement (laboratory) their solutions to problems that will have been posed in advance.

LEARNING OBJECTIVES OF THE SUBJECT

2.By the end of the course, students should be able to easily use the mathematical and geometric concepts and tools that are most useful in computer graphics.

STUDY LOAD

Type	Hours	Percentage
Self study	96,0	64.00
Hours large group	54,0	36.00

Total learning time: 150 h

CONTENTS

Basics of affine and metric geometry

Description:
Vectorial spaces.
Affine spaces. Coordinate systems. Affine manifolds in dimensions 2 and 3.
Euclidean spaces. Distances and angles. Projections. Cartesian coordinate systems.
Changing coordinates.

Linear geometric objects, curves and surfaces

Description:
Linear objects.
Curves in dimensions 2 and 3. Parametrizations. Rudiments of differential geometry of curves.
Surfaces in dimension 3. Parametrizations. Rudiments of differential geometry of surfaces.
Surface intersections.

Affine transforms

Description:
Rigid motions, similarities and affinities.
Euler and Tait-Bryan angles.
Using quaternions in rotations.

ACTIVITIES

Lectures

Description:
Presenting and discussing the subjects included in the syllabus

Specific objectives:
2

Related competencies :
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CG5. Capability to apply innovative solutions and make progress in the knowledge to exploit the new paradigms of computing, particularly in distributed environments.
CEE1.1. Capability to understand and know how to apply current and future technologies for the design and evaluation of interactive graphic applications in three dimensions, either when priorizing image quality or when priorizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.
CEC2. Capacity for mathematical modelling, calculation and experimental design in engineering technology centres and business, particularly in research and innovation in all areas of Computer Science.
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CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.

Full-or-part-time: 87h
Theory classes: 27h
Self study: 60h

Problems solving sessions

Description:
Solving, presenting and discussing problems

Specific objectives:
2

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CEE1.1. Capability to understand and know how to apply current and future technologies for the design and evaluation of interactive graphic applications in three dimensions, either when priorizing image quality or when priorizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.
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CB9. Possession of the learning skills that enable the students to continue studying in a way that will be mainly self-directed or autonomous.

Full-or-part-time: 50h
Practical classes: 20h
Self study: 30h

Lab sessions

Description:
Implementing solutions and visualizing their results

Specific objectives:
2

Related competencies :
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CEE1.1. Capability to understand and know how to apply current and future technologies for the design and evaluation of interactive graphic applications in three dimensions, either when priorizing image quality or when priorizing interactivity and speed, and to understand the associated commitments and the reasons that cause them.
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CB6. Ability to apply the acquired knowledge and capacity for solving problems in new or unknown environments within broader (or multidisciplinary) contexts related to their area of study.
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Full-or-part-time: 13h
Laboratory classes: 7h
Self study: 6h

GRADING SYSTEM

Along the course, students will get assigned some problems solving and implementing. This homework will be presented in class by the students, and revised by the instructor, giving as a result the homework component of the final grade (H) with a maximum of 5 points. There will also an exam at the end of course in class hours with a maximum score C of 5 points.

There will also be a final written exam, mainly devoted to problems solving, which will give the exam component of the final grade (E) with a maximum score of 10.

The final grade (F) will be obtained by the following formula: F = max (H+C, H+E/2, E).

BIBLIOGRAPHY

Basic:
- Trias Pairó, J. Geometría para la informática gráfica y CAD. Edicions UPC, 2003. ISBN 8483017024.

Complementary:
- Lengyel, E. Mathematics for 3D game programming and computer graphics. 3rd ed. Cengage Learning, 2011. ISBN 9781435458864.
- Agoston, M.K. Computer graphics and geometric modeling. Springer, 2004. ISBN 1852338180.
- Carmo, M.P. do. Differential geometry of curves and surfaces. Rev. & Upd. 2nd ed. Mineola, New York: Dover Publications, Inc., 2016. ISBN 9780486806990.
- Struik, D.J. Lectures on classical differential geometry. 2nd ed. Dover Publications, 1988. ISBN 0486656098.
- Berg, M. de [et al.]. Computational geometry: algorithms and applications. 3rd ed. Springer, 2008. ISBN 9783540779735.
- Farin, G.; Hansford, D. Practical linear algebra: a geometry toolbox. 3rd ed. CRC Press, Taylor & Francis, 2014. ISBN 9781466579569.

RESOURCES

Hyperlink:
- http://bibliotecnica.upc.edu/ - http://www.sagemath.org/ - https://cocalc.com/ - https://dccg.upc.edu/people/vera/teaching/courses/geometric-tools-for-computer-g