Course guide
804231 - MAT2VJ - Mathematics II

Last modified: 15/09/2024

Unit in charge: Image Processing and Multimedia Technology Centre
Teaching unit: 804 - CITM - Image Processing and Multimedia Technology Centre.

Degree: BACHELOR'S DEGREE IN VIDEO GAME DESIGN AND DEVELOPMENT (Syllabus 2014). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan, English

LECTURER

Coordinating lecturer: Angulo Bahon, Cecilio

Others: Angulo Bahon, Cecilio
Cayero Becerra, Julián Francisco

PRIOR SKILLS

Basic knowledge in linear algebra

REQUIREMENTS

None

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Generical:
CGFB1VJ. Solve mathematical problems that may arise in engineering. Apply knowledge of linear algebra; geometry; integral and differential calculus; numerical methods; statistics.

Transversal:
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

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.
04 COE N1. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.
CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

TEACHING METHODOLOGY

Lectures, Practical classes and code labs

LEARNING OBJECTIVES OF THE SUBJECT

- Describe and manipulate 2D and 3D geometric objects. Points, lines and planes.
- Transform geometric objects by means of displacements, rotations and symmetries.
- Project 3D objects onto a plane.
- Carry out geometric constructions and define animation trajectories in three-dimensional space.
- Correctly interpret conical and cylindrical perspectives.
- Know and master 3D graphic production tools.
- Use differential equations appropriately in modelling and solving problems, particularly those related to physical simulations.
- Identify one's own information needs and use the collections, spaces and services available to design and execute simple searches appropriate to the subject area.
- Carry out assigned tasks in the time foreseen, working with the indicated sources of information, in accordance with the guidelines set by the teaching staff.
- Show sufficient reading comprehension in reading documents written in English, related to the subject, such as books, notes, scientific articles, popular science articles, web pages, software manuals and others that may be specified by the teachers.

STUDY LOAD

Type	Hours	Percentage
Guided activities	10,0	6.67
Hours large group	34,0	22.67
Hours medium group	16,0	10.67
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Vectors. 2D and 3D Geometry

Description:
Vectors in R^2. Scalar product in R^2. Vector product in R^2: rotations. Complex numbers.
Vectors in R^3. Scalar product in R^3. Vector product in R^3.
Matrices. Matrices and vector products in R^3.
Determinants, inverse and adjoint matrices.

Related competencies :
CGFB1VJ. Solve mathematical problems that may arise in engineering. Apply knowledge of linear algebra; geometry; integral and differential calculus; numerical methods; statistics.

Full-or-part-time: 6h
Practical classes: 2h
Self study : 4h

Differential calculus with several variables

Description:
Functions in several variables. 2D objects given by contour lines. 3D objects given by level surfaces.
Vector-valued functions. Parameterized curves. Curvature and torsion.
Functions in several variables with vectorial values. Parameterized surfaces.
Coordinate systems.

Full-or-part-time: 8h
Theory classes: 4h
Practical classes: 4h

Geometric transformations in 2D and 3D

Description:
Linear transformations.
Scale transformations.
Orthogonal matrices. Orientation
Rotations. Derivation of the rotation matrix. Euler's theorem.

Full-or-part-time: 48h
Theory classes: 10h
Practical classes: 6h
Guided activities: 2h
Self study : 30h

Geometry for lighting and shading

Description:
Blinn-Phong lighting model.
Diffuse reflection. Specular reflection. Reflection of the environment and emissivity.
Tangent space. Calculation of tangent vectors. Construction of relief map.
Normal vector to a surface.

Full-or-part-time: 14h
Theory classes: 4h
Practical classes: 2h
Self study : 8h

Interpolation (I)

Description:
Interpolation between two points.
Weighted means and affine combinations.
Three points Interpolations. Barycentric coordinate system.
Bilinear interpolation. Projected convexity's condition. Inverse of bilinear interpolation.

Full-or-part-time: 18h
Theory classes: 8h
Practical classes: 2h
Guided activities: 2h
Self study : 6h

Interpolation (II): Bézier curves, B-Splines, NURBS

Description:
Bézier curves.
Particular case of Bézier curves for degree 3.
Method of De Casteliau.
Recursive subdivision.

Full-or-part-time: 16h
Theory classes: 6h
Practical classes: 2h
Guided activities: 2h
Self study : 6h

Ray-Tracing. Intersections

Description:
Basic Ray-Tracing
Intersection with rays.

Full-or-part-time: 14h
Theory classes: 4h
Practical classes: 2h
Guided activities: 2h
Self study : 6h

Animation

Description:
Animation of position.
"Ease in": fixed object.
"Ease in": moving object.
Application of orientation representations in animation.

Full-or-part-time: 8h
Theory classes: 2h
Practical classes: 2h
Self study : 4h

Kinematics

Description:
Articulated rigid joints.
Direct kinematics.
Inverse kinematics.

Full-or-part-time: 18h
Theory classes: 8h
Practical classes: 2h
Guided activities: 2h
Self study : 6h

GRADING SYSTEM

The final qualification will be calculated from the different evaluation items:

- Virtual class exercises (participation and learning attitude): 10%
- Laboratory exercises: 30%
- Project: 15%
- Partial exam: 15%
- Final Exam: 30%

If the pass mark is not obtained, there is the possibility of a reevaluation exam. The qualification of this examen will substitute those of the partial and final exams (45% of the final qualification). The maximum mark to be obtained in the reevaluation is 5.

Irregular actions that may lead to a significant variation of the grade of one or more students constitute a fraudulent performance of an evaluation act. This action entails the descriptive grade of failure and a numerical grade of 0 for the ordinary global evaluation of the course, without the right to re-evaluation.

If the lecturers have indications of the use of AI tools not allowed in the evaluation tests, they may summon the students concerned to an oral test or a meeting to verify the authorship.

EXAMINATION RULES.

All the activities and deliveries will be mandatory, if not completed they will be graded 0.

BIBLIOGRAPHY

Basic:

- Buss, Samuel R. 3-D computer graphics: a mathematical introduction with OpenGL. Cambridge [etc.]: Cambridge University Press, 2003. ISBN 0521821037.
- Dunn, F.; Parberry, I. 3D math primer for graphics and game development. 2nd ed. Boca Raton, Florida, EUA: CRC Press, 2011. ISBN 9781568817231.
- Gortler, Steven J. Foundations of 3D computer graphics. Cambridge, MA: MIT Press, 2012. ISBN 9780262017350.
- Lengyel, Eric; Smith, Emi. Mathematics for 3D game programming and computer graphics, third edition. 3rd ed. Boston: Cengage Learning, 2011. ISBN 1435458869.