Course guide
804231 - MAT2VJ - Mathematics II

Last modified: 09/09/2025

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: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, English

LECTURER

Coordinating lecturer: Angulo Bahon, Cecilio

Others: Angulo Bahon, Cecilio
Sors, Oriol

PRIOR SKILLS

Basic knowledge in linear algebra

REQUIREMENTS

None

TEACHING METHODOLOGY

Lectures, problem-based classes and code practices.

LEARNING OBJECTIVES OF THE SUBJECT

- To describe mathematically the main 2D and 3D geometric objects: points, lines and planes.

- To solve, through the use of mathematics, the possible problems that may arise in the design and development of video games.

- To correctly interpret the conical and cylindrical perspectives.

- To transform geometric objects through displacements, rotations and symmetries.

- To project 3D objects on a plane.

- To properly use the necessary mathematical tools in the resolution of analytical and numerical problems.

- To use geometric constructions with animation trajectories in three-dimensional space.

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.

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.