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804231 - MAT2VJ - Mathematics II

Coordinating unit: 804 - CITM - Image Processing and Multimedia Technology Centre

Teaching unit: 804 - CITM - Image Processing and Multimedia Technology Centre

Academic year: 2019

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

ECTS credits: 6 Teaching languages: Catalan, English

Teaching staff

Coordinator: Angulo Bahon, Cecilio

Others: Cayero Becerra, Julián Francisco

Opening hours

Timetable: To be determined by e-mail with cecilio.angulo@upc.edu

Degree competences to which the subject contributes

Generical:

CGFB1VJ. (ENG) Resoldre els problemes matemàtics que puguin plantejar-se en l'enginyeria. Aplicar els coneixements sobre: àlgebra lineal; geometria; càlcul diferencial i integral; mètodes numèrics; estadística.

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.

Learning objectives of the subject

- Describe and manipulate 2D and 3D geometric objects. Points, lines and planes.
- Transform geometric objects by translations, rotations and symmetries.
- Projection of 3D objects on a plane.
- Build geometric elements and define trajectories of animations in a 3D space.
- Interpret the conical and cylindrical perspectives.
- Know and use tools for 3D graphical production.
- Use differential equations for problems model and resolution, in particular those related with physical simulation.

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Study load

Total learning time: 150h	Hours large group:	34h	22.67%
	Hours medium group:	16h	10.67%
	Hours small group:	0h	0.00%
	Guided activities:	10h	6.67%
	Self study:	90h	60.00%

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Content

Vectors. 2D and 3D Geometry

Learning time: 6h

Practical classes: 2h
Self study : 4h

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.

Differential calculus with several variables.

Learning time: 8h

Theory classes: 4h
Practical classes: 4h

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.

Geometric transformations in 2D and 3D.

Learning time: 48h

Theory classes: 10h
Practical classes: 6h
Guided activities: 2h
Self study : 30h

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

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Geometry for lighting and shading.	Learning time: 14h Theory classes: 4h Practical classes: 2h Self study : 8h

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.

Interpolation (I)	Learning time: 18h Theory classes: 8h Practical classes: 2h Guided activities: 2h Self study : 6h

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.

Interpolation (II): Bézier curves, B-Splines, NURBS.	Learning time: 16h Theory classes: 6h Practical classes: 2h Guided activities: 2h Self study : 6h

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

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Ray-Tracing. Intersections.	Learning time: 14h Theory classes: 4h Practical classes: 2h Guided activities: 2h Self study : 6h

Description:
Basic Ray-Tracing
Intersection with rays.

Animation	Learning time: 8h Theory classes: 2h Practical classes: 2h Self study : 4h

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

Kinematics	Learning time: 18h Theory classes: 8h Practical classes: 2h Guided activities: 2h Self study : 6h

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

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Qualification system

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

- Class exercises: 10%
- Laboratory exercises (4): 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.

Regulations for carrying out activities

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.

Lengyel, Eric; Smith, Emi. Mathematics for 3D game programming and computer graphics, third edition. 3rd ed. Boston: Cengage Learning, 2011. ISBN 1435458869.

Gortler, Steven J. Foundations of 3D computer graphics. Cambridge, MA: MIT Press, 2012. ISBN 9780262017350.