Mathematics and Physics for Digital Animated Objects

Code: 104729
ECTS Credits: 6

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Degree	Type	Year
2503873 Interactive Communication	OB	2

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

The subject starts from very basic levels of mathematics and physics, but it would be helpful that the student had taken the subjects of Mathematics and Physics at the secondary grade.

Objectives and Contextualisation

This course aims to provide the basic mathematical and physical concepts needed to create 3D representations, so that students can apply them in fields such as game simulation, scientific visualization, computer animation, and virtual object design.

The initial topics are dedicated to introducing the basic elements that will be worked with later: points and vectors. We will learn to work with these objects to calculate distances between points and angles between vectors.

Once the essential elements are defined, we will create derived objects such as lines and planes. These form the foundation of 3D object creation. We will learn to visualize these objects based on the camera's position.

Finally, we will study the essential equations to describe object motion. Through numerical integration of the motion equations, we will learn to move objects in a world with and without gravity, as well as bounce off walls or the ground.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Apply and integrate knowledge in the fields of social sciences, humanities and engineering to generate complex products and services tailored to citizens' needs.
- Associate mathematical and physical processes and theories, and their application to the world of databases, with the creation of interfaces and with augmented virtual reality.
- Introduce changes in the methods and processes of the field of knowledge to provide innovative responses to the needs and demands of society.
- Manage time efficiently and plan for short-, medium- and long-term tasks.
- Search for, select and rank any type of source and document that is useful for creating messages, academic papers, presentations, etc.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.

Learning Outcomes

1. Analyse a situation and identify its points for improvement.
2. Assimilate the fundamental principles of mathematics and physics and apply them to the creation of communication products.
3. Construct the usual models for creating the animated objects, the parameters and the simulation.
4. Cross-check information to establish its veracity, using evaluation criteria.
5. Distinguish the salient features in all types of documents within the subject.
6. Explain the key concepts of this subject area, on the basis of the knowledge of physics and mathematics acquired in secondary school.
7. Interpret and analyse continuity in animated objects.
8. Interpret and analyse the relationship between mathematical concepts and the creation of databases.
9. Interpret and discuss documents and theories on physics and mathematics of animated digital objects.
10. Plan and conduct academic studies in the field of information systems.
11. Propose new methods or well-founded alternative solutions.
12. Propose projects and actions that are in accordance with the principles of ethical responsibility and respect for fundamental rights and obligations, diversity and democratic values.
13. Relate physical and mathematical concepts and apply them to the movement/force of animated objects.
14. Submit course assignments on time, showing the individual and/or group planning involved.

Content

In the first part of the course, we will study the mathematical concepts necessary for drawing, positioning, and orienting polygonal objects on the computer. These tools will allow us to draw simple objects and position them in 2D and 3D spaces. In the second part, we will study the essential physical laws that allow us to make objects move in these spaces.

1. Basic elements of mathematics.

Vector Spaces: Properties of vector spaces. Dot product. Linear combinations and basis. Vectors in 3 dimensions.
Matrices and Cross Product: Introduction to matrices. Identity and inverse matrices. Cross product. Solving systems of equations using matrices.
Transformations: Transformations in the plane. 3D transformations. Rotations around any axis. Homogeneous coordinates.

Equations of the Line: Lines in the plane. Distances. Relative position between lines. Geometric loci. Lines in 3D.
Equations of the Plane: Planes in 3D space. Intersection of lines and planes. Intersection of planes. Distance from a point to a plane. Projection onto the viewing plane.

2. Foundations of Physics

Equations of Motion: Uniform linear motion and uniformly accelerated motion.
Circular motion.
Newton's Laws. Weight, Normal force, Frictional forces.
Collisions between objects.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Computer practices	15	0.6	3, 4, 5, 7, 10
Theory classes	33	1.32	3, 6, 7, 8, 9, 13
Type: Supervised			
Tutorials	8	0.32	4, 5
Type: Autonomous			
Programming	20	0.8	2, 3, 5, 7, 13, 14
Reading of educational material	12	0.48	2, 4, 9
Resolution of computer assisted questionaries	16	0.64	3, 7, 13
Workhome	26	1.04	4, 9, 10, 14

The classes will alternate different methodologies:

- Theory classes where the general concepts of the different topics will be introduced

- Self-corrected questionnaires using the Moodle platform

- Practices writting short programs applying the concepts introduced in theory classes.

- Reading of didactic material where the physical and mathematical concepts are used to draw and move objects in virtual environments.

The calendar will be available on the first day of class. Students will find all information on the Virtual Campus: the description of the activities, teaching materials, and any necessary information for the proper follow-up of the subject. In case of a change of teaching modality for health reasons, teachers will make readjustments in the schedule and methodologies

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
1st Mid-term exam	30%	2	0.08	2, 3, 6, 13
2nd Mid-term exam	30%	2	0.08	2, 3, 6, 13
Geogebra/Python practice	20%	8	0.32	1, 2, 7, 8, 11, 12, 14
Moodle questionaries	20%	8	0.32	4, 5, 9, 10, 13, 14

CONTINUOUS ASSESSMENT:

The final grade is divided into two partial exams, each accounting for 30% of the grade, and Moodle and Geogebra/Python practical exercises accounting for the remaining 40%.

In order to calculate the average, the grade for each of the four items (2 partial exams - Moodle - Geogebra/Blender) must be higher than 3.5.

The teaching methodology and evaluation proposed may be subject to modifications based on the restrictions on in-person activities imposed by the health authorities.

SINGLE ASSESSMENT:

The final grade is divided into two partial exams, each accounting for 35% of the grade, and the in-person delivery and explanation of a Blender simulation accounting for the remaining 30%.

In order to calculate the average, the grade for each of the three items (2 partial exams - Blender practice) must be higher than 3.5.

RESIT EXAM:

According to regulations, in order to participate in the recovery process, students must have been previously evaluated in at least 2/3 of the total assessable activities of the subject.

If a student has failed any of the partial exams, they will have the option to take a resit exam for the specific partial they failed. These exams will be the same as those used in the continuous assessment as well as in the regular evaluation.

If any of the practical exercises have been failed, the Moodle questionnaire will remain open for a few hours so that the exercise can be repeated.

Once the recovery activities have been completed, the final grade for the subject will be determined by replacing the failed grades with the grades obtained in this phase, using the same weighting as inthe regular phase.

Bibliography

1. Lengyel, Eric, and Flynt, John. *Mathematics for 3D Game Programming and Computer Graphics (3rd Edition)*. Boston: Course Technology, 2011. ProQuest Ebook Central. (Accessible com a recurs electrònic a https://ebookcentral-proquest-com.are.uab.cat/lib/uab/detail.action?docID=3136454#)

2. Bourg, David M. and Bywalec, B. *Physics for game developers (2nd edition)*. , 2013. O'Reilly.

Software

-GEOGEBRA: https://www.geogebra.org

-BLENDER: https://www.blender.org/

Language list

Name	Group	Language	Semester	Turn
(SEM) Seminars	61	Catalan	second semester	morning-mixed
(SEM) Seminars	62	Catalan	second semester	morning-mixed
(TE) Theory	6	Catalan	second semester	afternoon