Course guide
804232 - FIS2VJ - Physics II

Last modified: 02/09/2025

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: Manuel Rello

Others: Manuel Rello
Eduard Garcia
Anna Argudo
Christian Martínez

PRIOR SKILLS

Knowledge about Physics and coding.

TEACHING METHODOLOGY

Theory classes consist of:

- Exposition of physics concepts, examples of application to video games.

- Physics exercises.

Practice classes consist of training exercises of the course APIs (Box2D).

The activity times will be modulated according to the complexity of the exercises and the corresponding contents.

Support material will be used and will be made available to the students through Atenea.

LEARNING OBJECTIVES OF THE SUBJECT

- Identify modelling and simulation methods in the field of video game design and programming.

- Apply common modelling and simulation methods in the design and programming of video games and realistic animations.

- Validate experimental results in the field of video game development.

- Use game engines in the simulation of the laws of physics.

- Effectively argue in prepared speeches, debates and answers to questions.

- Collaborate effectively and responsibly as a member or leader of a team, in interdisciplinary contexts or not, considering the available resources.

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

Physics and Maths Review

Description:
Review of basic concepts of physics and mathematics:

- Summary of vector, differential and integral calculus.
- Coordinate systems.
- Solving the equations of motion and types of motion. Study of the damped harmonic oscillator.
- Review of collisions.

Full-or-part-time: 13h
Theory classes: 6h
Practical classes: 2h
Self study : 5h

Rigid Body Mechanics

Description:
Description of the rigid body:

- Torque (moment of a force).
- Angular momentum, angular momentum conservation theorem, and kinetic energy.
- Center of mass. Moment of inertia and the parallel and perpendicular axis theorems.
- Rotational dynamics and statics.

Full-or-part-time: 16h 50m
Theory classes: 6h
Practical classes: 4h 10m
Self study : 6h 40m

Forces of physics

Description:
Main forces in physics applied to videogames:

- Gravitation.
- Electrostatics.
- Magnetism.

Full-or-part-time: 15h
Theory classes: 6h
Practical classes: 4h
Self study : 5h

Continuum mechanics

Description:
Continuum mechanics:

- Hydrostatics.
- Hydrodynamics.
- Elasticity of continuous media.

Full-or-part-time: 23h
Theory classes: 6h
Practical classes: 2h
Self study : 15h

Box2D integration

Description:
- Analyzing the Box2D API.
- Integration plan.
- Binding creation.
- Collision detection.
- Integrators.
- Raytracing
- Physics simulation.

Full-or-part-time: 23h 30m
Practical classes: 6h 50m
Self study : 16h 40m

ACTIVITIES

Project Box2D (Classical Physics)

Description:
The objective is to learn to use the Box2D physics library.
- The students shall use Box2D as a physics engine to create a classical physics game.

Activities:
- Defining goals and limitations.
- Creating a environment for simulations.
- Coding the interactive elements.
- Victory conditions.

Full-or-part-time: 11h
Guided activities: 3h
Self study: 8h

Project Box2D (Custom physics)

Description:
The objective is to learn to use the Box2D physics library.
- The students shall use Box2D as a physics engine to create a custom physics game.

Activities:
- Definition of the goals and limitation of racing games.
- Creating the environment for the simulations.
- Car creation.
- Victory conditions.

Full-or-part-time: 16h
Guided activities: 4h
Self study: 12h

GRADING SYSTEM

The grade of the course will be obtained following a continuous evaluation system. The weight of each part is as follows:

Theory: 45%.

- Continuous evaluation: 10%.
- Midterm exam: 15%.
- Final exam: 20%.

Laboratory: 45%

- Project 1: Classic Physics: 15%
- Project 1 Presentation: 5%
- Project 2: Custom physics: 20%
- Project 2 presentation: 5%.

Participation and attitude towards learning: 10% (5% theory, 5% practice).

Students who fail will have the chance to take the reevaluation exam. The mark of this exam will replace the mark of the midterm and final exams and, in case of passing the course, the maximum final mark will be 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.

In-class exercises:
During the classes, students will work on problems that will be discussed and solved during the same session. These exercises will help with the development of the projects and with gaining physical intuitions applicable to video game development.

Projects:
The projects will be done in groups and they will be delivered before the established deadline. The delivery includes de developed code, a functional release of the game, and a technical report if necessary.

BIBLIOGRAPHY

Basic:
- Eberly, David H. Game Physics [on line]. 2nd ed. Burlington, MA: Morgan Kaufmann, 2010 [Consultation: 14/07/2025]. Available on: https://doi-org.recursos.biblioteca.upc.edu/10.1201/b18213. ISBN 9780080964072.
- Bourg, David M. Physics for game developers . 2nd ed. Beijing: O'Reilly, 2013. ISBN 978-1449392512.
- M. Alonso, E. J. Finn. Física.
- Paul A. Tipler, Gene Mosca. Física para la ciencia y la tecnología.

Complementary:
- Palmer, Grant. Physics For Game Programmers. 1st ed. Apress, 2005. ISBN 978-1590594728.
- Millington, Ian. Game Physics Engine Development. 2nd ed. CRC Press, 2017. ISBN 1138403121.
- Parberry, I. Introduction to game physics with Box2D. 1st ed. Boca Raton: CRC Press, 2013. ISBN 9781466565760.
- Szauer, Gabor. Game Physics Cookbook. 1st ed. Packt Publishing, 2017. ISBN 978-1787123663.
- van den Bergen, Gino. Game Physics Pearls. 1st ed. CRC Press, 2010. ISBN 978-1-56881-474-2.
- Ericson, Christer. Real-Time Collision Detection. 1st ed. Morgan Kaufmann, 2005. ISBN 978-0080474144.

RESOURCES

Hyperlink:
- GDC (Game Developer's Conference). https://www.youtube.com/c/Gdconf- SIGGRAPH (Association for Computing Machinery's (ACM) Special Interest Group on Computer Graphics and Interactive Techniques). https://www.youtube.com/user/ACMSIGGRAPH