# Course guide
# 804232 - FIS2VJ - Physics II

**Last modified:** 27/07/2025

**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:** Manel Rello

**Others:** Manel 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

- Know and understand the principles of mechanics typically associated with video game development: direct and inverse kinematics; motion of rigid and articulated solids, deformation of solids and collision detection.

- Ability to create games based on 2D physics simulations.

- Be able to apply physics models to 2D video games and simulations.

- Understand the structure of the Box2D library.

## 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 the physical concepts given in Physics 1 and basics calculus tools:
- Overview on vector and differential calculus.
- Coordinate systems. Relative position of physical bodies in the 3D space and collisions.
- Kinematics 1D, 2D and 3D.
- Dynamics: motion under forces, non-frictional and frictional systems.
- Momentum balance and collisions 1D and 2D (purely elastic, inelastic, breakage).
- Integration and Transformations.

**Full-or-part-time:** 18h 50m
Theory classes: 3h 30m
Practical classes: 2h
Self study : 13h 20m

### Rigid Body Dynamics

**Description:**
Description of kinematics and dynamics of the rigid body:
- Review on matrix calculus.
- Momentum conservation. Angular momentum.
- Center of mass. Inertia.
- Rotational movement 2D and 3D: Pure translation and pure rotation.
- Rotational dynamics 2D and 3D: forces and torques.
- Rigid body transformation: 2D and 3D displacement and rotation, deformation.

**Full-or-part-time:** 21h 40m
Theory classes: 4h
Practical classes: 2h 40m
Self study : 15h

### Physics Forces

**Description:**
Main physics forces applied to videogames:
- Gravity: constant, scaled, lineal, universal law of gravitation, ropes and cables.
- Aerodynamics: lift, drag.
- Hydrodynamics: flotación, drag, sustentación.
- Oscillations: harmonic motion, springs.
- Electromagnetism and light.

**Full-or-part-time:** 27h 20m
Theory classes: 6h
Practical classes: 6h 20m
Self study : 15h

### Box2D integration

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

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

## ACTIVITIES

### Project Box2D (Pinball)

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

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

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

**Project Box2D (Racing Game)**

**Description:**
The objective is to learn to use the Box2D physics library.
- The students shall use Box2D as a physics engine to create a Racing car game (or alike).

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
Self study: 12h
Guided activities: 4h

## 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%

- Pinball project: 15%
- Pinball Project Presentation: 5%
- Racing Game Project: 20%
- Presentation of Racing Game Project: 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 lectures, students will develop exercises to be discussed and solved in the same lecture. These exercises will be useful to do the projects.

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