804232 - FIS2VJ - Physics 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)
ECTS credits: 6
Teaching languages: Catalan, Spanish, English

Teaching staff
Coordinator: Sureda Anfres, Miquel
Others: Randino Zancajo, Carlos

Prior skills
Knowledge about Physics and coding in C++

Degree competences to which the subject contributes

Generical:
CGFC1VJ. (ENG) Dissenyar, desenvolupar, seleccionar i avaluar aplicacions i sistemes informàtics d’o per a videojocs, assegurant la seva fiabilitat, seguretat i qualitat, d’acord amb principis ètics i la legislació i normativa vigent.
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.
CGFB2VJ. (ENG) Interpretar y dominar los conceptos básicos sobre las leyes generales de la mecánica, la termodinámica, los campos y las ondas y el electromagnetismo; y su aplicación para la resolución de problemas propios de la ingeniería.

Transversal:
05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

Teaching methodology
The weekly theory lectures consist in 2 hours (1 session of 2 h).
During the sessions:
- Theory lectures (new concepts and basic tools, with application examples)
- In-class tutorials

Activities schedule may change, depending on the difficulty of the exercises and the corresponding contents. The supporting material to be used will be available at the virtual campus site.

Learning objectives of the subject
- To understand the structure of the Box 2D and Bullet libraries.
- Knowledge on how to create games based on physics simulations in both 2D and 3D.
- To be able to apply physical models to video games and simulations in both 2D and 3D.
# Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>34h</th>
<th>22.67%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>16h</td>
<td>10.67%</td>
</tr>
<tr>
<td></td>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>10h</td>
<td>6.67%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
## Content

| **Box2D integration** | **Learning time:** 15h  
Theory classes: 6h  
Self study: 9h |
|-----------------------|---------------------------------------------------|
| **Description:**      | - Analyzing the Box2D API.  
- Integration plan.  
- Binding creation in C++.  
- Collision detection.  
- Physics simulation. |

| **Creation of a videogame with 2D physics** | **Learning time:** 15h  
Theory classes: 6h  
Self study: 9h |
|---------------------------------------------|---------------------------------------------------|
| **Description:**                           | - Defining goals and limitations.  
- Creating an environment for simulations.  
- Coding the interactive elements.  
- Victory conditions. |

| **Integration of Bullet3D** | **Learning time:** 15h  
Theory classes: 6h  
Self study: 9h |
|-----------------------------|---------------------------------------------------|
| **Description:**            | - Analyzing the API of Bullet3D.  
- Integration plan.  
- Binding creation in C++.  
- Collision detection.  
- Physics simulation. |

| **Creating a video game using 3D physics** | **Learning time:** 20h  
Theory classes: 8h  
Self study: 12h |
|-------------------------------------------|---------------------------------------------------|
| **Description:**                          | - Definition of the goals and limitation of racing games.  
- Creating the environment for the simulations.  
- Car creation.  
- Victory conditions. |
## Physics Review

**Learning time:** 20h
- Theory classes: 8h
- Self study: 12h

**Description:**
Review of the physical concepts given in Physics 1 and basics calculus tools:
- Overview on vectorial 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)

## Rigid Body Dynamics

**Learning time:** 40h
- Theory classes: 16h
- Self study: 24h

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

## Harmonic Movement

**Learning time:** 15h
- Theory classes: 6h
- Self study: 9h

**Description:**
Basics on harmonic oscillations
- Harmonic movement equations
- Travelling and damped waves.
- Sound and light. Light properties: velocity, propagation, reflection, refraction and diffraction
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Qualification system

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

- Partial Exams 20%
- Final Exam 25%
- Practice Box2d 15%
- Practice Bullet 30%
- Participation and attitude 10%

The approved one is obtained when obtaining a note of 5 in the final grade weighted according to the previous criterion. If you do not present an exam or practical exercise, you will get a score of 0. If the subject is not passed, there is the possibility of presenting a re-evaluation exam. The maximum grade in the reassessment will be 5 and only the theoretical part will be reassessed.

Regulations for carrying out activities

In-class exercises:
During the theory lectures, students will develop exercises to be discussed and solved in the same lecture. These exercises act as training to do the Tutorial Exercises (individual).

Tutorial Exercises (TE):
At the beginning of each package, the corresponding tutorial exercises (TE) will be delivered, and should be submitted within the indicated deadline, in pdf format. Complementary material (Excel, Matlab, Phyton), if convenient, should be submitted as well.

Bibliography

Basic: