COURSE DATA

DATA SUBJECT

Code: 34846
Name: Simulation
Cycle: Undergraduate Studies
ECTS Credits: 6
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1407 - Degree in Multimedia Engineering	Escola Tècnica Superior d'Enginyeria	3	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1407 - Degree in Multimedia Engineering	Animación y Simulación por Computador	COMPULSORY

COORDINATION

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SUMMARY

Simulation is a compulsory course within the subject Computer Animation and Simulation, taught in the second semester of the third year of the Bachelor's Degree in Multimedia Engineering.

The objective of the Simulation course is to review the main modeling and simulation techniques used in the field of computer graphics engineering, where the goal is to visualize and interact with simulation models created within a 2D/3D graphical application. Typically, civil/military engineering simulators (e.g., training, vehicles, aircraft, educational tools) and entertainment or 2D/3D gaming applications represent the type of interactive graphic application studied in this course.

Both physics-based models and AI-based models (for decision-making in game characters) will be studied and implemented. The physics models fall within the scope of classical mechanics, where we will revisit key kinematic and dynamic problems of simulated solids, along with the numerical integration techniques required to simulate their behavior.

The course will begin with a review of the mathematical and physical foundations, covering vector and matrix algebra and the kinematics of rigid and articulated bodies (already introduced in the Animation course during the first semester). In parallel, we will revisit 2D/3D graphic environments in which the

implemented physical behaviors can be visualized. The laboratory sessions are especially relevant here, where a subset of the simulation models studied in class will be implemented and tested.

The physical simulation of rigid body behavior (dynamics) will lead to the study of common models for constraints (joints), deformations, and collisions. Given that collision handling is essential in most interactive graphical applications, various approaches will be studied and one lab session will be dedicated to this topic. To conclude this core section of the course, a topic on complex simulations has been included, aiming to explore simulation models that, due to their complexity, go beyond the scope of the previously studied physics. This includes fluid and particle simulation (special effects such as smoke, explosions, etc.).

Finally, the course also covers key artificial intelligence models commonly used in interactive games to simulate different types of decision-making in intelligent agents (e.g., flocking, pathfinding, decision trees).

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

Having passed the following courses: Physics, Mathematics, Programming, Graphic Computing and advanced graphics and sound. It is very important having passed Animation in the first semester

COMPETENCES / LEARNING OUTCOMES

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G1 - Be able to relate and structure information from different sources and to integrate ideas and knowledge. (RD1393/2007)

G4 - Be able to integrate into working groups and collaborate in multidisciplinary environments and be able to communicate properly with professionals from all fields.

I10 - e able to design and evaluate human-computer interfaces that ensure accessibility and usability of computer systems, services and applications.

MM10 - Be able to analyse and integrate software components to develop multimedia applications.

MM1 - Have knowledge and ability to understand essential facts, concepts, principles and theories related to multimedia systems including all the disciplines covered by these systems.

MM21 - Communicate effectively, both in writing and verbally, knowledge, procedures, results and ideas related to ICT and specifically to multimedia, and know their socioeconomic impact.

MM22 - Have knowledge and ability to understand essential facts, concepts, principles and theories related to multimedia and to the spectrum of reference disciplines.

MM24 - Be able to design, develop, evaluate and ensure the accessibility, ergonomics, usability and security of multimedia systems, services and applications and of the information that these manage.

MM28 - Be able to solve problems with initiative, decision-making and creativity and to communicate and transmit the knowledge, abilities and skills of a multimedia engineer.

MM2 - Be able to understand and manage the different technologies involved in multimedia systems, both from the point of view of hardware and electronics and of software.

MM3 - Be able to implement methodologies, technologies, processes and tools for the professional development of multimedia products in a real context of use by applying the appropriate solutions for each environment.

MM7 - Be able to apply the principles of audiovisual graphic design and communication to multimedia products.

MM8 - Integrate knowledge of different multimedia technologies to create products that offer global solutions that are appropriate to each context.

MM9 - Program correctly in the different specific languages of multimedia systems taking into account time and cost restrictions.

DESCRIPTION OF CONTENTS

1. Introduction to graphical simulation

Fundamentals of graphic simulation. Basics. Kinematics of rigid bodies.
Interactive graphics applications: games physics engines.

2. Physical models

Particle simulation. Emitters
Colisions
Hash table

3. Deformable objects

Soft bodies: Spring-mass (damper) system.
Wave simulation.

4. Rigid bodies

Angular velocity
Rigid Body dynamics: torque and angular momentum

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	30,00
Laboratory	20,00
Classroom practices	10,00
Total hours	**60,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	3,00
Individual or group project	30,00
Independent study and work	22,00
Preparation of lessons	24,00
Preparation for assessment activities	6,00
Resolution of case studies	5,00
Total hours	**90,00**

TEACHING METHODOLOGY

Teaching will consist of a combination of lectures, problem sessions and practical activities to be performed by the student. This teaching will be supplemented by individual work of students, focusing on the study, problem solving, and job preparation for delivery. In addition, there will be sessions on lab work with your computer.

- The theoretical activities consist of conducting master classes on topics that will be developed to provide a global and inclusive, analyzing in detail the key issues and more complex, promoting at all times, student participation.
- Practical activities consist of seminars, which will address topics on applications and less formal aspects of the subject and conducting hands-on labs. Laboratory sessions will consist in solving problems related to the theoretical contents through the implementation of the techniques developed.
- The student's personal work consists mainly in three aspects:
    - preparing lessons in advance and recommended reading texts
    - problem solving proposed by Professor

Development works will be delivered to Professor.

EVALUATION

In the first call, a continuous evaluation model will be followed:

Continuous evaluation (basic rules):

1) Throughout the course, tasks will be proposed that will be evaluated individually (laboratory sessions, assignments, etc).

2) The theoretical-practical contents of the course will be evaluated through one or more partial exams, through a final exam, and through the completion of a portfolio of exercises.

3) The laboratory sessions will be evaluated by means of a report of each practice and/or by means of a questionnaire to be handed in at the end of the session and/or by means of the evaluation of the code handed in and/or by means of an individual exam on the contents of the practice. Each laboratory statement will indicate its evaluation system.

4) The rest of the evaluable tasks will be selected by the teacher among the following categories: problems, projects, individual work or group work.

5) At any time, the teacher will be able to summon the students to individually defend the work done in any of the submitted assignments.

6) A student will go to the second call if any of the following situations are fulfilled:

a) A student fails to pass or fails to deliver on time two or more of the proposed assignments.

b) A student submits a copied assignment (this may affect more students).

c) A student is unable to explain or maintain an argument on issues related to the code, on the decisions made or on the wording of any of the assignments he/she has handed in.

The final grade will be:

0.4*(Lab grade) + 0.6*(Theory grade).

The minimum grade to be able to average both parts will be 4 points in both cases.

If a student cannot attend the course for justified reasons, he/she must inform the professor at the

beginning of the course, in order to establish a work plan equivalent to the classroom work.

Second call:

In second call a theoretical-practical exam will be carried out and the grade will be: 0.4*(Laboratory grade) + 0.6*(Theoretical-practical exam grade).

The laboratory grade will be that of the first exam and will not require a minimum grade. The minimum grade of the exam to be able to average it will be a 4.

In any case, the evaluation of the subject will be in accordance with the Evaluation and grading regulations of the Universitat de València for bachelor's and master's degrees approved by the Governing Council of May 30, 2017 (ACGUV 108/2017).

Copying or plagiarism of any activity that is part of the evaluation will result in the impossibility of passing the course, and the student will then be subject to the appropriate disciplinary procedures indicated in the ACTION PROTOCOL FOR FRAUDULENT PRACTICES AT THE UNIVERSITY OF VALENCIA (ACGUV 123/2020).

REFERENCES

- [Eberly04] - Davis H. Eberly ¿Game Physics¿. Elsevier. 2004.
- [Lengyel04] ¿ E. Lengyel. ¿Mathematics for 3D game programming and computer graphics¿. Charles River Media. 2004
- [Ramtal11] ¿ Dev Ramtal y Adrian Dobre. ¿The Essential Guide to Physics for Flash Games, Animation, and Simulations¿. APress, 2011
- [Parent08] ¿ Rick Parent, ¿Computer Animation ¿ Algorithms and Techniques¿ Morgan Kaufmann 2008.
- [Bourg02] ¿ David M. Bourg ¿Physics for Game Developers¿ O'Really 2002.
- [VanDenBergen] ¿ G. van den Berger ¿Game physics pearls¿ A.K. Peters. 2010.
- [Akenine08] ¿ Akenine ¿ Moller. ¿Real Time Rendering¿ . A.K. Peters 2010.