

**1. General information****Course:** VIRTUAL AND AUGMENTED REALITY**Type:** CORE COURSE**Degree:** 2362 - MÁSTER UNIVERSITARIO EN INGENIERÍA INFORMÁTICA (CR) - (2020)**Center:** 108 - SCHOOL OF COMPUTER SCIENCE OF C. REAL**Year:** 1**Main language:** Spanish**Use of additional languages:****Web site:****Code:** 311048**ECTS credits:** 6**Academic year:** 2023-24**Group(s):** 20**Duration:** First semester**Second language:** English**English Friendly:** Y**Bilingual:** N**Lecturer:** JAVIER ALONSO ALBUSAC JIMENEZ - Group(s): 20

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2. Pre-Requisites

Adequate experience in computer programming is necessary in order to be able to deal with the practical part of the course.

3. Justification in the curriculum, relation to other subjects and to the profession

This course is included in the 'Computing' module, together with 'High-Performance Computing' and 'Intelligent Systems Development'. The main objective of this course is to train the student in the fundamentals of visualization in information interaction, with special emphasis on new techniques such as Virtual Reality (VR) and Augmented Reality (AR).

In recent years there has been a rapid evolution in the techniques of interaction and visualization of information, allowing the user to immerse in a virtual environment (VR) or even integrate virtual information in real scenarios (AR). The needs of qualified personnel in the sector are remarkable, specifically in the direction and management of multidisciplinary work teams, in the field of video games, cinema, television, industrial design, scientific visualizations, simulations, etc.

In this context, this course deals with the main areas of knowledge in the field of modern computer interaction techniques and information synthesis methods.

4. Degree competences achieved in this course**Course competences**

Code	Description
CE13	Ability to use and develop methodologies, techniques and programmes for specific uses, rules and computer standard graphics.
CE14	Ability to conceptualise, design, develop and assess the interaction between the user and the machine in the use of products, applications and IT services.
CE15	Ability to create and utilise virtual environments in the creation, management and distribution of multimedia content.
INS01	Analysis, synthesis and assessment skills.
INS04	Problem solving skills by the application of engineering techniques.
INS05	Argumentative skills to logically justify and explain decisions and opinions.
PER01	Team work abilities.
SIS01	Critical thinking.
SIS03	Autonomous learning.
UCLM02	Ability to use Information and Communication Technologies.

5. Objectives or Learning Outcomes**Course learning outcomes****Description**

Use human-computer interaction techniques to facilitate navigation through the represented models and information, as well as the selection and manipulation of specific models or information

Visualise, design, develop, evaluate and exploit complex interactive systems, from multimedia systems to virtual worlds

Use computer graphics and multimedia methods to produce artificial, realistic and hybrid models and information by computer

6. Units / Contents**Unit 1: Introduction to Visualization by Computers****Unit 2: Fundamentals of Interactive Representation****Unit 3: Advanced Interaction Models (I) - Augmented Reality****Unit 4: Advanced Interaction Models (II) - Virtual Reality**

Unit 5: Realistic Rendering Techniques

ADDITIONAL COMMENTS, REMARKS

Throughout the course, a prototype information visualization system will be built using new interaction paradigms. The development of the system will be done in an incremental way following the scheme of the following sessions:

Practice 1. Introduction to the work environment.

Practice 2. Interactive representation systems.

Practice 3. Augmented reality systems.

Practice 4. Virtual Reality, Realistic Rendering and Multimedia Contents

Additional sessions: Presentation of projects.

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Lectures	CE13 CE14 CE15 SIS01 UCLM02	0.72	18	N		Teaching of the subject matter by lecturer (MAG)
Class Attendance (theory) [ON-SITE]	Problem solving and exercises	CE13 CE14 CE15 INS01 INS04 INS05 SIS01 UCLM02	0.56	14	Y	N	Teaching of the subject matter by lecturer (MAG)
Laboratory practice or sessions [ON-SITE]	Practical or hands-on activities	CE13 CE14 CE15 INS01 INS04 INS05 SIS01 SIS03 UCLM02	0.64	16	Y	N	Realization of practicals in laboratory /computing room (LAB)
In-class Debates and forums [ON-SITE]	Debates	INS01 INS05 SIS01 SIS03	0.16	4	Y	N	Discussions on actual cases or related current proposals.
Individual tutoring sessions [ON-SITE]	Other Methodologies	INS01 INS04 INS05 SIS01	0.16	4	Y	N	Individual or small group tutoring in lecturer's office, classroom or laboratory (TUT)
Other on-site activities [ON-SITE]	Assessment tests	CE13 CE14 CE15 INS01 INS04 INS05 SIS01	0.16	4	Y	Y	Assessment tests
Study and Exam Preparation [OFF-SITE]	Self-study	CE13 CE14 CE15 INS01 INS04 INS05 SIS01 SIS03 UCLM02	1.8	45	N		Self-study (EST)
Writing of reports or projects [OFF-SITE]	Project/Problem Based Learning (PBL)	CE13 CE14 CE15 INS01 INS04 INS05 SIS01 SIS03 UCLM02	0.6	15	Y	N	Preparation of essays on topics proposed by lecturer (RES)
Practicum and practical activities report writing or preparation [OFF-SITE]	Practical or hands-on activities	CE13 CE14 CE15 INS01 INS04 INS05 SIS01 SIS03 UCLM02	1.2	30	Y	Y	Preparation of laboratory practices (PLAB)
Total:			6	150			
Total credits of in-class work: 2.4			Total class time hours: 60				
Total credits of out of class work: 3.6			Total hours of out of class work: 90				

As: Assessable training activity

Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Test	20.00%	0.00%	Compulsory activity that can be retaken (rescheduling) to be carried out within the planned exam dates of the final exam call (convocatoria ordinaria).
Final test	0.00%	40.00%	Compulsory activity that can be retaken (rescheduling). Final test of the entire subject matter [ESC]
Assessment of problem solving and/or case studies	60.00%	40.00%	Case Study proposed at the beginning of the course. Non-compulsory and recoverable activity. Submission of exercises through Campus Virtual (online).
Laboratory sessions	10.00%	10.00%	Compulsory activity that can be retaken. To be carried out during lab sessions
Assessment of active participation	10.00%	10.00%	Non-compulsory activity that can be retaken. To be carried out during the theory/lab sessions. In the case of students under non-continuous evaluation can participate in Campus Virtual forums or M. Teams channels, or event solving some proposed optional exercises, which may need an oral defense.
Total:	100.00%	100.00%	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject, an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:**Continuous assessment:**

In compulsory activities, a minimum mark of 40% is required in order to pass that activity and have the possibility to therefore pass the entire subject. A compulsory activity cannot be divided into eliminatory parts, nor can minimum marks be established for each of its parts. In the case of the activities that may be retaken (i.e., rescheduling), an alternative activity or test will be offered in the resit/retake exam call (convocatoria extraordinaria).

The partial tests will be common for all the theory/laboratory groups of the subject and will be evaluated by the lecturers of the subject in a serial way, i.e., each part of the partial tests will be evaluated by the same lecturer for all the students. A student is considered to pass the subject if she/he obtains a minimum of 50 points out of 100, taking into account the points obtained in all the evaluable activities, and also has passed all the compulsory activities.

For students who do not pass the subject in the final exam call (convocatoria ordinaria), the marks of activities already passed will be conserved for the resit/retake exam call (convocatoria extraordinaria). If an activity is not recoverable, its assessment will be preserved for the resit/retake exam call (convocatoria extraordinaria) even if it has not been passed. In the case of the passed recoverable activities, the student will have the opportunity to receive an alternative evaluation of those activities in the resit/retake exam call and, in that case, the final grade of the activity will correspond to the latter grade obtained.

The mark of the passed activities in any call, except for the partial tests, will be conserved for the subsequent academic year at the request of the student, provided that mark is equal or greater than 50% and that the activities and evaluation criteria of the subject remain unchanged prior to the beginning of that academic year.

The failure of a student to attend the partial 1 and partial 2 tests will automatically result in her/him receiving a "Failure to attend" (no presentado). If the student has not passed any compulsory evaluation activity, the maximum final grade will be 40%.

Non-continuous evaluation:

Students may apply at the beginning of the semester for the non-continuous assessment mode. In the same way, the student may change to the non-continuous evaluation mode as long as she/he has not participated during the teaching period in evaluable activities that together account for at least 50% of the total mark of the subject. If a student has reached this 50% of the total obtainable mark or the teaching period is over, she/he will be considered in continuous assessment without the possibility of changing to non-continuous evaluation mode.

Students who take the non-continuous evaluation mode will be globally graded, in 2 annual calls per subject, an ordinary and an extraordinary one (evaluating 100% of the competences), through the assessment systems indicated in the column "Non-continuous evaluation".

In the "non-continuous evaluation" mode, it is not compulsory to keep the mark obtained by the student in the activities or tests (progress test or partial test) taken in the continuous assessment mode.

Specifications for the resit/retake exam:

Evaluation tests will be conducted for all recoverable activities.

The failure of a student to attend the partial 1 and partial 2 tests will automatically result in her/him receiving a "Failure to attend" (no presentado), except in the case that the student conserves the mark for partial 1 and partial 2 from the final exam call (convocatoria ordinaria). In the latter case, the student's carrying out of any other evaluable activity in the resit/retake exam call (convocatoria extraordinaria) will result in a numerical mark.

Specifications for the second resit / retake exam:

Evaluation tests will be conducted for all recoverable activities.

9. Assignments, course calendar and important dates	
Not related to the syllabus/contents	
Hours	hours
General comments about the planning: This course will be taught in 1.5 hour sessions spread over the school calendar.	

10. Bibliography and Sources						
Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
Kerlow, I. V.	The art of 3-D computer animation and effects	John Wiley & Sons		0-471-43036-6	2004	
Shreiner, D.	OpenGL Programming Guide: The Official Guide to Learning OpenGL Versions 3.0 and 3.1. (7th Edition)	Addison-Wesley		978-032155-262-4	2009	
Suffern, K and Hu, H.H.	RayTracing from the Ground Up	A.K. Peters		978-1-56881-272-4	2007	
Akenine-Möller, T and Haines, E	Real-Time Rendering (3rd Edition)	A.K. Peters		987-1-56881-424-7	2008	
Schmalstieg, D (Dieter)	Augmented reality : principles and practice /	Addison-Wesley,		0-321-88357-8	2016	
Grubert, Jens (1983-)	Augmented reality for Android application development : lear	Packt,		978-1-78216-855-3 (r	2013	
Dell Wolfensparger	Apple ARKit Revealed: Augmented and Mixed Reality for iPhone and iPad	Apress		1484233689	2018	
Erin Pangilinan, Steve Lukas, Vasanth Mohan	Creating Augmented and Virtual Realities: Theory & Practice for Next-Generation Spatial Computing	O'Reilly			2019	
Jonathan Linowes , Krystian Babilinski	Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia	Packt			2017	