ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

103000392 - Intelligent Virtual Environments: Technologies, Architectures And Applications

DEGREE PROGRAMME

10AK - Master Universitario En Software Y Sistemas

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	103000392 - Intelligent Virtual Environments: Technologies, Architectures And Applications
No of credits	4 ECTS
Type	Optional
Academic year ot the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	10AK - Master Universitario en Software y Sistemas
Centre	10 - Escuela Tecnica Superior De Ingenieros Informaticos
Academic year	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Jose Maria Barambones Ramirez	5106	j.barambones@upm.es	M - 10:00 - 12:00 Tu - 10:00 - 12:00 W - 10:00 - 12:00
Angelica De Antonio Jimenez (Subject coordinator)	5108	angelica.deantonio@upm.es	W - 10:30 - 14:00 Th - 09:30 - 12:00 Previous appointment is needed. Contact at angelica.deantonio @upm.es

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Skills and learning outcomes *

3.1. Skills to be learned

CEM1 - Identificar, a partir del estado de la cuestión, la presencia de problemas de investigación relacionados con la concepción, la construcción, el uso y la evaluación de sistemas sociotécnicos complejos que hagan un uso intensivo de software

CEM9 - Evaluar las tecnologías más innovadoras para la interacción persona-ordenador y juzgar de manera crítica las aportaciones a los problemas de investigación relacionados

CG12 - Comprensión amplia de las técnicas y métodos aplicables en una especialización concreta, así como de sus límites

CG13 - Apreciación de los límites del conocimiento actual y de la aplicación práctica de la tecnología más reciente.

CG2 - Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios.

CG4 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CG7 - Especificación y realización de tareas informáticas complejas, poco definidas o no familiares

CG8 - Planteamiento y resolución de problemas también en áreas nuevas y emergentes de su disciplina

CG9 - Aplicación de los métodos de resolución de problemas más recientes o innovadores y que puedan implicar el uso de otras disciplinas

CGI20 - Adquirir conocimientos científicos avanzados del campo de la informática que le permitan generar nuevas ideas dentro de una línea de investigación.

CGI23 - Capacidad de leer y comprender publicaciones dentro de su ámbito de estudio/investigación, así como su catalogación y valor científico

3.2. Learning outcomes

RA74 - Capacidad de plantear y llevar a la práctica el diseño de una investigación en el ámbito de las tecnologías y arquitecturas para entornos virtuales inteligentes

RA73 - Capacidad de plantear y llevar a la práctica el diseño de una investigación en el ámbito de las capacidades de los agentes virtuales inteligentes

RA71 - Capacidad de plantear un proyecto de construcción de un entorno virtual inteligente, estableciendo el proceso a seguir, las tecnologías a utilizar, las posibilidades de interacción a ofrecer, y el rol a desempeñar por los agentes virtuales inteligentes, y seleccionar las tecnologías, arquitecturas y herramientas más apropiadas para llevarlo a cabo

RA72 - Capacidad de plantear y llevar a la práctica el diseño de una investigación en el ámbito de la interacción persona?ordenador en el contexto de un entorno virtual inteligente

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

4. Brief description of the subject and syllabus

4.1. Brief description of the subject

This subject allows deepening into Intelligent Virtual Environments as a specific kind of computer systems:

- with very peculiar characteristics regarding human computer interaction (three dimensional environments in which the user is immersed and interacts with the objects, other users and autonomous agents)
- with specific technologies that support their construction and use (Virtual Reality and Augmented Reality devices)
- with very important and promising applications that demand more research and development efforts (such as educational or design applications)
- and still with many open challenges and research opportunities for the future

The main research and development trends in the area of Intelligent Virtual Environments will be presented, with a special focus on the peculiarities of 3D interaction, the challenges associated with the design of intelligent virtual

agents, and educational applications.

4.2. Syllabus

1. Virtual Reality and Augmented Reality Technologies
   1.1. Basic Concepts in Virtual and Augmented Reality
   1.2. Devices and Technologies for Virtual and Augmented Reality
   1.3. Specific Challenges in Augmented Reality
2. Virtual Environment Development
   2.1. Tasks for the Development of a Virtual Environment
   2.2. VE Development Tools
3. 3D Interaction tasks, techniques and challenges
4. Virtual Humans
   4.1. Architecture and Components of a Virtual Human
   4.2. Perception in a Virtual Human
   4.3. The Mind of a Virtual Human
   4.4. Actuation Capabilities in a Virtual Human
5. Virtual Reality and Augmented Reality Applications

5. Schedule

5.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Subject Presentation** Duration: 02:00 Lecture			
2	**Chapter 1 - VR and AR Concepts** Duration: 02:00 Lecture			
3	**Chapter 1 - VR and AR Technologies** Duration: 02:00 Lecture			
4	**Chapter 1 - VR and AR Technologies** Duration: 02:00 Lecture			**Reading test in Moodle** Online test Continuous assessment and final examination Not Presential Duration: 04:00
5	**Chapter 1 - Specific Challenges in AR** Duration: 02:00 Lecture			
6	**Chapter 2 - Tasks for VE development** Duration: 02:00 Lecture			
7	**Chapter 2 - Tasks for VE development** Duration: 02:00 Lecture			**Reading Test in Moodle** Online test Continuous assessment and final examination Not Presential Duration: 04:00
8		**Chapter 2 - VE Development Tools** Duration: 02:00 Laboratory assignments		
9		**Chapter 2 - VE Development Tools** Duration: 02:00 Laboratory assignments		
10	**Chapter 3 - 3D Interaction** Duration: 02:00 Lecture			**Reading test in Moodle** Online test Continuous assessment and final examination Not Presential Duration: 04:00
11	**Chapter 3 - 3D Interaction** Duration: 02:00 Lecture			

12	**Chapter 4 - Architecture and Components of a Virtual Human** Duration: 02:00 Lecture			
13	**Chapter 4 - Perception in a Virtual Human** Duration: 02:00 Lecture			**Reading Test in Moodle** Online test Continuous assessment and final examination Not Presential Duration: 04:00
14	**Chapter 4 - The Mind of a Virtual Human** Duration: 02:00 Lecture			
15	**Chapter 4 - Actuation capabilities in a Virtual Human** Duration: 01:00 Lecture **Chapter 5 - XR Applications** Duration: 01:00 Lecture			
16				**Participation in the classroom** Other assessment Continuous assessment Presential Duration: 00:00 **Presentation of Research and Development Work** Individual presentation Continuous assessment and final examination Presential Duration: 06:00 **Research Work** Individual work Continuous assessment and final examination Not Presential Duration: 24:00 **VE development practice** Individual work Continuous assessment and final examination Not Presential Duration: 24:00
17				

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
4	Reading test in Moodle	Online test	No Presential	04:00	5%	/ 10	CG4 CGI23
7	Reading Test in Moodle	Online test	No Presential	04:00	5%	/ 10	CG4 CGI23
10	Reading test in Moodle	Online test	No Presential	04:00	5%	/ 10	CG4 CGI23
13	Reading Test in Moodle	Online test	No Presential	04:00	5%	/ 10	CG4 CGI23
16	Research Work	Individual work	No Presential	24:00	30%	4 / 10	CEM1 CG2 CG4 CG8 CG12 CG13 CGI20 CGI23 CEM9
16	Presentation of Research and Development Work	Individual presentation	Face-to-face	06:00	15%	5 / 10	CEM1 CG8 CG12 CG13 CGI20
16	Participation in the classroom	Other assessment	Face-to-face	00:00	5%	/ 10	
16	VE development practice	Individual work	No Presential	24:00	30%	4 / 10	CG4 CG7 CG9 CG12 CG13

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills

4	Reading test in Moodle	Online test	No Presential	04:00	5%	/ 10	CG4 CGI23
7	Reading Test in Moodle	Online test	No Presential	04:00	5%	/ 10	CG4 CGI23
10	Reading test in Moodle	Online test	No Presential	04:00	5%	/ 10	CG4 CGI23
13	Reading Test in Moodle	Online test	No Presential	04:00	5%	/ 10	CG4 CGI23
16	Research Work	Individual work	No Presential	24:00	30%	4 / 10	CEM1 CG2 CG4 CG8 CG12 CG13 CGI20 CGI23 CEM9
16	Presentation of Research and Development Work	Individual presentation	Face-to-face	06:00	15%	5 / 10	CEM1 CG8 CG12 CG13 CGI20
16	VE development practice	Individual work	No Presential	24:00	30%	4 / 10	CG4 CG7 CG9 CG12 CG13

6.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Reading tests in Moodle	Online test	Face-to-face	09:00	20%	/ 10	CG4 CGI23
Research work	Individual work	Face-to-face	20:00	30%	4 / 10	CEM1 CG2 CG4 CG8 CG12 CG13 CGI20 CGI23 CEM9

VE development practice	Individual work	Face-to-face	20:00	30%	4 / 10	CG4 CG7 CG9 CG12 CG13
Presentation of Research and Development Work	Individual presentation	Face-to-face	05:00	15%	5 / 10	CEM1 CG8 CG12 CG13 CGI20
Participation in the classroom	Other assessment	Face-to-face	00:00	5%	/ 10	

6.2. Assessment criteria

Course evaluation system

The course has a theoretical and a practical side.

The theoretical part will be dealt with through lectures and the established mandatory readings. This part will be evaluated via Moodle tests.

The practical part will be evaluated with two individual works.

1. A research work that consists on an initiation to research. Each student will deepen into one of the topics proposed by the professors.

A report will be produced as a result of the research work. This report should have a minimum length of 15 pages, not counting references. The report should offer a historical perspective (what has been done, and when) as well as a technical perspective (description of the main results in the area, viewpoints, contributions...). A critical approach and the identification of research opportunities will be positively valued.

The work can also consist on the design of an experimental work. In this case, an application area will be chosen, one or more interesting hypotheses should be posed, and a procedure to test the hypotheses should be designed.

For each document or paper that has been read in the preparation of the report (even if finally it was not relevant and cited in the report) a brief summary paragraph should be written. The report should include an appendix with all these summaries.

At the end of the semester, each student should perform a final presentation of the work and the results obtained.

2. A development work that consists on the creation of one or more virtual or augmented reality systems, according to the guidelines provided.

The weights for the assessment of the different activities are as follows:

- Moodle Tests: 20%

- Research Work: 30%, comprising:
  - Final report: 25%
  - Bibliographic Analysis: 5%
- Development Work: 30%

- Final Presentation: 15%
- Participation in the classroom: 5%

All activities, except for the participation in the classroom, can be delivered progressively or as a global evaluation at the end of the semester.

Extraordinary evaluation

Only the evaluation activities not submitted for the ordinary evaluation (progressive or global), or those that have not reached the minimum grade, can be submitted for the extraordinary evaluation. For all previously submitted activities, the grades obtained in ordinary evaluation will be considered for the computation of the final grade.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
Understanding Virtual Reality: Interface, Application, and Design, William R. Sherman, Alan Craig, Morgan Kaufmann, 2003	Bibliography	
3D User Interfaces: Theory and Practice, Doug A. Bowman, Ernst Kruijff, Joseph J. LaViola, Ivan Poupyrev, Addison-Wesley Professional, 2004	Bibliography	
Cassell, J. (2001) Embodied conversational agents: representation and intelligence in user interfaces, AI Magazine, Volume 22, Issue 4, pp. 67 - 83	Bibliography	
Designing Virtual Worlds, Richard Bartle, New Riders Games, 2003	Bibliography	
Animated agents for procedural training in virtual reality: Perception, cognition and motor control. Rickel, J., Johnson, W. L. Applied Artificial Intelligence 13, 343-382, 1999	Bibliography	
Dehn, D., van Mulken, S. (2000) The impact of animated interface agents: a review of empirical research, Int. J. Human-Computer Studies, 52, 1-22	Bibliography	
Gratch, J.; Rickel, J. et al ?Creating Interactive Virtual Humans: some assembly required? IEEE Intelligent systems july/august 2002, pp.2-11.	Bibliography	

Greenhalgh, C., Benford, S. and Reynard, G., A QoS Architecture for Collaborative Virtual Environments, ACM Multimedia (MM'99), Orlando, Florida, November, 1999, ACM Press	Bibliography	
M.R. Macedonia, and M. J. Zyda: ?A Taxonomy for Networked Virtual Environments?, IEEE Multimedia, Jan-Mar, 1997, pp. 48-56.	Bibliography	
D.A. Bowman, L.F. Hodges (1997). An Evaluation of Techniques for Grabbing and Manipulating Remote Objects in Immersive Virtual Environments. Proceedings of the ACM Symposium on Interactive 3D Graphics, pp. 35-38.	Bibliography	
Sitio Moodle de la asignatura (http://moodle.upm.es/titulaciones/oficiales/course/view.php?id=2580)	Web resource	
http://electronics.howstuffworks.com/gadgets/other-gadgets/virtual-reality.htm	Web resource	
http://computer.howstuffworks.com/augmented-reality.htm	Web resource	
Ronald T. Azuma. A survey of augmented reality. Presence: Teleoperators and Virtual Environments, 6(4):355? 385, August 1997	Bibliography	
"A Taxonomy of Mixed Reality Visual Displays." IEICE Transactions on Information Systems E77-D (12): 1321-1329	Bibliography	

Unity Learn https://learn.unity.com/	Web resource	
Oculus for Developers https://developer.oculus.com/resources/	Web resource	

8. Other information

8.1. Other information about the subject

The course is related to the Sustainable Development Goals SDG3, SDG4 and SDG9.

- SDG3 Good Health and Wellbeing - Ensuring healthy lives and promoting well-being at all ages is essential to sustainable development. Extended Reality is successfully being applied in the health domain, with interesting applications in rehabilitation, psychological treatment, improvement of physical and cognitive state in older people, and others. The course presents the potential of XR in this domain.
- SDG4 Quality Education - Education enables upward socioeconomic mobility and is a key to escaping poverty. Extended Reality can increase the opportunities to access high quality education and training. The course presents the potential of XR in this domain.
- SDG9 Industry, Innovation and Infrastructure - Least developed countries, in particular, need to accelerate the development of their manufacturing sector. Extended Reality can help to minimize the cost of training manufacturing personnel, planning and evaluating manufacturing processes. The course presents the potential of XR in this domain.

9. Adendas

- Se incorpora al profesorado de la asignatura: Cristian Moral Martos. A new professor has been added to the course: Cristian Moral Martos