



POLITÉCNICA

INTERNATIONAL
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COORDINATION PROCESS OF
LEARNING ACTIVITIES
PR/CL/001



E.T.S. de Ingenieros
Informáticos

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

103000879 - Virtual Intelligent Systems

DEGREE PROGRAMME

10AZ - Master Universitario En Innovación Digital

ACADEMIC YEAR & SEMESTER

2024/25 - Semester 1

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1. Description

1.1. Subject details

Name of the subject	103000879 - Virtual Intelligent Systems
No of credits	4 ECTS
Type	Optional
Academic year of the programme	Second year
Semester of tuition	Semester 3
Tuition period	September-January
Tuition languages	English
Degree programme	10AZ - Master Universitario en Innovación Digital
Centre	10 - Escuela Tecnica Superior De Ingenieros Informaticos
Academic year	2024-25

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

Cristian Moral Martos	5110	cristian.moral@upm.es	W - 10:00 - 14:00 Th - 12:00 - 14:00
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* 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

CB06 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

CB07 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio

CB08 - 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

CB09 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades

CE-DIPO02 - Capacidad para evaluar la interacción persona-ordenador de productos y servicios de alto valor innovador

CE-DIPO03 - Habilidad para hacer conexiones entre los deseos y necesidades del consumidor o cliente y lo que la tecnología puede ofrecer

CG03 - La capacidad de usar la lengua inglesa de manera competente, es decir, con capacitación para tareas complejas de trabajo y estudio.

CG06 - Capacidad para gestionar la información.

3.2. Learning outcomes

RA31 - Be able to sketch a project for the development of an intelligent virtual environment, establishing the process to be followed, the technologies to be used, the interaction possibilities to offer, and the role to be played by intelligent virtual agents, selecting the most appropriate technologies, architectures and tools for the development.

RA32 - Be able to design and conduct a research process in the área of technologies, architectures, intelligent agent capabilities, or human-computer interaction, in the context of an intelligent virtual environment

RA99 - Understand tools and process needed to deploy virtual reality applications

* 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 and Tools 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	Type 1 activities	Type 2 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 Progressive assessment and Global Examination Not Presential Duration: 00:00
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 - VE Development Tools Duration: 02:00 Laboratory assignments			Reading Test in Moodle Online test Progressive assessment and Global Examination Not Presential Duration: 00:00
8	Chapter 2 - VE Development Tools Duration: 02:00 Laboratory assignments			
9	Chapter 3 - 3D Interaction Duration: 02:00 Lecture			
10	Chapter 3 - 3D Interaction Duration: 02:00 Lecture			Reading test in Moodle Online test Progressive assessment and Global Examination Not Presential Duration: 00:00
11	Chapter 4 - Architecture and Components of a Virtual Human Duration: 01:00 Lecture Chapter 4 - Perception in a Virtual Human Duration: 01:00 Lecture			

12	Chapter 4 - The Mind of a Virtual Human Duration: 02:00 Lecture			
13	Chapter 4 - Actuation capabilities in a Virtual Human Duration: 01:00 Lecture	Testing of VE development practice (in small groups to be determined) Duration: 02:00 Laboratory assignments		Reading Test in Moodle Online test Progressive assessment and Global Examination Not Presential Duration: 00:00
14	Chapter 5 - XR Applications Duration: 01:00 Lecture	Testing of VE development practice (in small groups to be determined) Duration: 02:00 Laboratory assignments		
15	Presentation of Research and Development Work (session 1) Duration: 02:00 Additional activities Presentation of Research and Development Work (session 2) Duration: 02:00 Additional activities			Presentation of Research and Development Work (session 1) Individual presentation Progressive assessment and Global Examination Presential Duration: 02:00 Presentation of Research and Development Work (session 2) Individual presentation Progressive assessment and Global Examination Presential Duration: 02:00
16				Participation in the classroom (attendance and active participation along the semester). Cannot be recovered in global evaluation Other assessment Progressive assessment Presential Duration: 00:00 Research Work Group work Progressive assessment and Global Examination Not Presential Duration: 00:00 VE development practice Group work Progressive assessment and Global Examination Not Presential Duration: 00:00
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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.

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	00:00	5%	/ 10	CB06
7	Reading Test in Moodle	Online test	No Presential	00:00	5%	/ 10	CB06
10	Reading test in Moodle	Online test	No Presential	00:00	5%	/ 10	CB06
13	Reading Test in Moodle	Online test	No Presential	00:00	5%	/ 10	CB06
15	Presentation of Research and Development Work (session 1)	Individual presentation	Face-to-face	02:00	7.5%	5 / 10	CB09 CG03
15	Presentation of Research and Development Work (session 2)	Individual presentation	Face-to-face	02:00	7.5%	5 / 10	CB09 CG03
16	Participation in the classroom (attendance and active participation along the semester). Cannot be recovered in global evaluation	Other assessment	Face-to-face	00:00	5%	/ 10	
16	Research Work	Group work	No Presential	00:00	30%	4 / 10	CB06 CB08 CB09 CG03 CG06
16	VE development practice	Group work	No Presential	00:00	30%	4 / 10	CB07 CG03 CE-DIPO02 CE-DIPO03

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
4	Reading test in Moodle	Online test	No Presential	00:00	5%	/ 10	CB06
7	Reading Test in Moodle	Online test	No Presential	00:00	5%	/ 10	CB06
10	Reading test in Moodle	Online test	No Presential	00:00	5%	/ 10	CB06
13	Reading Test in Moodle	Online test	No Presential	00:00	5%	/ 10	CB06
15	Presentation of Research and Development Work (session 1)	Individual presentation	Face-to-face	02:00	7.5%	5 / 10	CB09 CG03

15	Presentation of Research and Development Work (session 2)	Individual presentation	Face-to-face	02:00	7.5%	5 / 10	CB09 CG03
16	Research Work	Group work	No Presential	00:00	30%	4 / 10	CB06 CB08 CB09 CG03 CG06
16	VE development practice	Group work	No Presential	00:00	30%	4 / 10	CB07 CG03 CE-DIPO02 CE-DIPO03

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	CB06
Research work	Individual work	Face-to-face	20:00	30%	4 / 10	CB06 CB08 CB09 CG03 CG06
VE development practice	Individual work	Face-to-face	20:00	30%	4 / 10	CB07 CG03 CE-DIPO02 CE-DIPO03
Presentation of Research and Development Work	Individual presentation	Face-to-face	05:00	15%	5 / 10	CB09 CG03
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.

Each group will be assigned a slot of 2 hours for testing their system in the Madrid HCI Laboratory, using virtual reality devices, either on week 13 or 14.

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

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.