

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

593000609 - Wireless Sensor Networks

DEGREE PROGRAMME

59AJ - Master Universitario En Comunicaciones Inalámbricas

ACADEMIC YEAR & SEMESTER

2024/25 - Semester 2

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1. Description

1.1. Subject details

Name of the subject	593000609 - Wireless Sensor Networks
No of credits	4.5 ECTS
Type	Optional
Academic year of the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	59AJ - Master Universitario en Comunicaciones Inalámbricas
Centre	59 - Escuela Técnica Superior De Ingeniería Y Sistemas De Telecomunicación
Academic year	2024-25

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
David Luengo Garcia (Subject coordinator)	A7011, D8201A	david.luengo@upm.es	Sin horario. Meetings with prior appointment.
Alejandro Garcia Lamperez	A7010	alejandro.garcia.lamperez@ upm.es	Sin horario. Meetings with prior appointment.

* 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

CB6 - 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/ Students have demonstrated knowledge and understanding providing the groundwork or opportunity for innovation in developing and/or applying ideas, often within a research context

CB7 - 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/Students are capable of applying their knowledge, understanding, and problem-solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study

CB8 - 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/Students are capable of integrating knowledge and making complex decisions, which, although based on incomplete or limited information, require reflection on social and ethical responsibilities linked to the application of their knowledge and opinions

CGI02 - Comprender el procedimiento, valor y límites del método científico, siendo capaz de identificar, localizar y obtener datos requeridos en un trabajo de investigación, de diseñar y guiar investigaciones analíticas, de modelado y experimentales, así como de evaluar datos de una manera crítica y extraer conclusiones. / Understand the procedure, value, and limits of the scientific method, being able to identify, locate and obtain data required in a research work, to design and guide analytical, modeling, and experimental investigations, as well as to critically evaluate data and extract conclusions.

CGI03 - Valorar la importancia de las fuentes documentales, manejarlas y buscar la información para el desarrollo de cualquier trabajo de investigación. / Assess the importance of documentary sources, manage them and search for information for the development of any research work.

CGI04 - Leer y comprender publicaciones dentro de su ámbito de estudio/investigación, así como su catalogación y valor científico. / Read and understand publications within their field of study / research, as well as their cataloging and scientific value.

UPM1 - Uso de la lengua inglesa / Use of the English language

UPM4 - Organización y planificación / Planning and organization

3.2. Learning outcomes

RA30 - Identificar el impacto social y económico de las redes de sensores inalámbricos en un contexto global/ Identify the social and economic impact of wireless sensor networks in a global context

RA31 - Diseñar una solución WSN para un caso de uso real/ Design a WSN solution for a real use case

RA28 - Programar nodos WSNs y diseñar su despliegue y supervisión/ Program WSNs nodes and design their deployment and supervision

RA27 - Distinguir entre las tecnologías, topologías y arquitecturas de WSN: WPAN y LPWAN/ Distinguish between WSN technologies, topologies, and architectures: WPAN and LPWAN

RA3 - Elegir los métodos y herramientas matemáticas necesarios para abordar la solución de un problema/ Choose the mathematical methods and tools necessary to tackle the solution of a problem

* 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 course aims to introduce Wireless Sensor Networks (WSNs) by using the cognitive communications concept. Implementation of WSNs equipped with real-time positioning devices will also be introduced.

4.2. Syllabus

1. Introduction to Wireless Sensor Networks (WSNs)
 - 1.1. Background
 - 1.2. Applications
 - 1.3. Hot Topics
2. Physical Layer and Medium Access Control
 - 2.1. Modulation and Radio Technologies
 - 2.2. Medium Access Control (MAC)
3. Routing Strategies and Protocols
 - 3.1. Basic Theory of Routing Protocols
 - 3.2. Topology Control Protocols
 - 3.3. QoS Routing in WSNs
4. Cognitive WSNs
 - 4.1. Cognitive Radio Networks and Dynamic Spectrum Access
 - 4.2. Cognitive Diversity Routing
 - 4.3. Weighted Cognitive Maps to Enable Cognition
5. WSN Development
 - 5.1. Lab Development Environment
 - 5.2. Use Case Example (Guided Example)
 - 5.3. WSN Project Development (Student's Project)

5. Schedule

5.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	Introduction to WSNs Duration: 02:00 Physical Layer and Medium Access Duration: 02:00			
2	Physical Layer and Medium Access Duration: 02:00 Physical Layer and Medium Access Duration: 02:00			Group Work - Introduction to WSNs Progressive assessment and Global Examination Presential Duration: 00:00
3	Physical Layer and Medium Access Duration: 01:00 Physical Layer and Medium Access Duration: 01:00 WSN Routing Strategies and Protocols Duration: 02:00			
4	WSN Routing Strategies and Protocols Duration: 02:00 WSN Routing Strategies and Protocols Duration: 01:30			Group Work - Physical and MAC Layer Progressive assessment and Global Examination Presential Duration: 00:00 Test 1 - Introduction + Physical/MAC Layers Progressive assessment and Global Examination Presential Duration: 00:30
5	WSN Routing Strategies and Protocols Duration: 01:00 WSN Routing Strategies and Protocols Duration: 01:00 Cognitive WSNs Duration: 02:00			

6	Cognitive WSNs Duration: 02:00 Cognitive WSNs Duration: 01:30			Group Work - Routing Strategies and Protocols Progressive assessment and Global Examination Presential Duration: 00:00 Test 2 - Routing Strategies & Protocols Progressive assessment and Global Examination Presential Duration: 00:30
7	Cognitive WSNs Duration: 02:00 Cognitive WSNs Duration: 02:00			
8		Lab Development Environment Duration: 01:30		Group Work - Cognitive WSNs Progressive assessment and Global Examination Presential Duration: 00:00 Test 3 - Cognitive WSNs Progressive assessment and Global Examination Presential Duration: 00:30
9		Use Case Example (Guided Project) Duration: 02:00		
10		Use Case Example (Guided Project) Duration: 02:00		
11		WSN Project Development (Student's Project) Duration: 02:00		Use Case Example (Guided Project) Progressive assessment and Global Examination Presential Duration: 00:00
12		WSN Project Development (Student's Project) Duration: 02:00		
13		WSN Project Development (Student's Project) Duration: 02:00		

14		WSN Project Development (Student's Project) Duration: 02:00		
15				WSN Project Development (Student's Project) Progressive assessment and Global Examination Presential Duration: 00:00
16				
17				Global Test (Only for Students Failing the Progressive Evaluation) Global examination Not Presential Duration: 01:00

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
2	Group Work - Introduction to WSNs		Face-to-face	00:00	5%	/ 10	CB7 CB8 CB6 CGI02 CGI03 CGI04 UPM1 UPM4
4	Group Work - Physical and MAC Layer		Face-to-face	00:00	5%	/ 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
4	Test 1 - Introduction + Physical/MAC Layers		Face-to-face	00:30	15%	/ 10	CB6 CB7 CB8 UPM1
6	Group Work - Routing Strategies and Protocols		Face-to-face	00:00	5%	/ 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
6	Test 2 - Routing Strategies & Protocols		Face-to-face	00:30	10%	/ 10	CB6 CB7 CB8 UPM1
8	Group Work - Cognitive WSNs		Face-to-face	00:00	5%	/ 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1

							UPM4
8	Test 3 - Cognitive WSNs		Face-to-face	00:30	15%	/ 10	CB6 CB7 CB8 UPM1
11	Use Case Example (Guided Project)		Face-to-face	00:00	10%	/ 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
15	WSN Project Development (Student's Project)		Face-to-face	00:00	30%	/ 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4

6.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	Group Work - Introduction to WSNs		Face-to-face	00:00	5%	/ 10	CB7 CB8 CB6 CGI02 CGI03 CGI04 UPM1 UPM4
4	Group Work - Physical and MAC Layer		Face-to-face	00:00	5%	/ 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
4	Test 1 - Introduction + Physical/MAC Layers		Face-to-face	00:30	15%	/ 10	CB6 CB7 CB8 UPM1
6	Group Work - Routing Strategies and Protocols		Face-to-face	00:00	5%	/ 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1

							UPM4
6	Test 2 - Routing Strategies & Protocols		Face-to-face	00:30	10%	/ 10	CB6 CB7 CB8 UPM1
8	Group Work - Cognitive WSNs		Face-to-face	00:00	5%	/ 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
8	Test 3 - Cognitive WSNs		Face-to-face	00:30	15%	/ 10	CB6 CB7 CB8 UPM1
11	Use Case Example (Guided Project)		Face-to-face	00:00	10%	/ 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
15	WSN Project Development (Student's Project)		Face-to-face	00:00	30%	/ 10	CB6 CB7 CB8 CGI02 CGI03 CGI04 UPM1 UPM4
17	Global Test (Only for Students Failing the Progressive Evaluation)		No Presential	01:00	40%	/ 10	CB8 CB6 CB7 UPM1

6.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

6.2. Assessment criteria

The progressive evaluation of this course consists of three parts:

- 1) Written exams at the end of units 1-2 (15%), unit 3 (10%) and unit 4 (15%).
- 2) Individual/group works (depending on the number of students) to be submitted at the end of the first four units of the course (10% each).
- 3) Group works to be submitted as part of the practical (lab) part of the course: guided project (10%) and student's project (30%).

Parts 2 and 3 (individual and group works) must be done during the course and are not recoverable later during the final or extraordinary evaluation. The marks of these two parts will be maintained for the final and extraordinary evaluations if the student fails to pass the course through the progressive evaluation.

Part 1 (written exams) can be recovered during the final and/or extraordinary evaluation in the date set by the School as part of the yearly evaluation calendar.

No minimum mark is set in any of the three parts of the evaluation.

7. Teaching resources

7.1. Teaching resources for the subject

Name	Type	Notes
M. Ibnkahla, "Wireless Sensor Networks: A Cognitive Perspective", CRC Press, 2017	Bibliography	
P. K. Singh, B. K. Bhargava, M. Paprzycki and N. C. Kaushal, "Handbook of Wireless Sensor Networks", Springer, 2020.	Bibliography	

H. M. A. Fahmy, "Concepts, Applications, Experimentation and Analysis of Wireless Sensor Networks", Springer, 2017 (2nd Ed).	Bibliography	
Dargie, W. and Poellabauer, C., "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley, 2010	Bibliography	Available on-line through IEEEExplore (https://ieeexplore.ieee.org/servlet/opac?bknumber=8039611)
Förster, A. "Introduction to Wireless Sensor Networks", Wiley 2016	Bibliography	Available on-line through IEEEExplore (https://ieeexplore.ieee.org/servlet/opac?bknumber=7906176)
Akyildiz, Ian F. and Mehmet Can Vuran. "Wireless sensor networks." John Wiley & Sons, 2010	Bibliography	Available on-line through IEEEExplore (https://ieeexplore.ieee.org/servlet/opac?bknumber=8039664)
On-Line Resources	Web resource	Journal and conference papers and other material available on-line, especially for recent and hot-topics.