LEARNING GUIDE

IOT ENVIRONMENT DESIGN

MÁSTER EN INGENIERÍA DE TELECOMUNICACIÓN

ACADEMIC YEAR	CODE	COURSE	CREDITS	TYPE	SEMESTER
2026-27	93001372	1	5 ECTS	COMPULSORY	SECOND SEMESTER

LANGUAGE	ASSIGNED CENTER
SPANISH, ENGLISH	E.T.S. DE INGENIEROS DE TELECOMUNICACION

ASSIGNED DEPARTMENT
INGENIERÍA ELECTRÓNICA

COORDINATOR
PATRICIA ARROBA GARCÍA - p.arroba@upm.es

REQUIRED PREREQUISITES

REQUIRED COURSES

—

RECOMMENDED PRIOR KNOWLEDGE

RECOMMENDED COURSES

—

OTHER RECOMMENDATIONS

C Programming Language

Digital Systems

Electronics

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RESULTS

RD-822/2021

Knowledge

KG1 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

KE11 Conocimiento de los lenguajes de descripción hardware para circuitos de alta complejidad

Skills

HG2 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

HE13 Capacidad para aplicar conocimientos avanzados de fotónica y optoelectrónica, así como electrónica de alta frecuencia

Competences

CE12 Capacidad para utilizar dispositivos lógicos programables, así como para diseñar sistemas electrónicos avanzados, tanto analógicos como digitales. Capacidad para diseñar componentes de comunicaciones como por ejemplo encaminadores, conmutadores, concentradores, emisores y receptores en diferentes bandas

CG3 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

CE15 Capacidad para la integración de tecnologías y sistemas propios de la Ingeniería de Telecomunicación, con carácter generalista, y en contextos más amplios y multidisciplinares como por ejemplo en bioingeniería, conversión fotovoltaica, nanotecnología, telemedicina

CG4 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

CG5 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

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CT4	Capacidad para trabajar de forma efectiva como individuo, organizando y planificando su propio trabajo, de forma independiente o como miembro de un equipo
CT3	Capacidad para adoptar soluciones creativas que satisfagan adecuadamente las diferentes necesidades planteadas
CT1	Capacidad para comprender los contenidos de documentación en lengua inglesa
CE10	Capacidad para diseñar y fabricar circuitos integrados

DESCRIPTION

This course introduces students to the design and development of advanced IoT solutions, from the design and implementation of the smart node to its integration into distributed architectures and connected environments. Throughout the course, key topics are addressed, including IoT node hardware/software management, reliability- and energy-efficiency-oriented design, wireless connectivity, device interoperability, and the computing and communication models used in current IoT solutions. With an application-oriented approach focused on real-world use cases, the course combines laboratory sessions and an integrated project, enabling students to acquire a practical and comprehensive understanding of the deployment of IoT systems.

TOPICS

1. Topic 1: The IoT Node

- 1.1. Introduction to IoT and WSN
- 1.2. Hardware Components of the IoT Node
- 1.3. Software for Managing the Hardware Components of the IoT Node

2. Topic 2: Design for Reliability and Low Power Consumption

- 2.1. Reliability-Oriented Software Design in IoT Nodes
- 2.2. Low-Power-Oriented Software Design in IoT Nodes

3. Topic 3: Wireless Connectivity and Interoperability Standards in IoT

- 3.1. IoT Network Architectures and Topologies

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ACTIVITIES

Assessment activity Learning activity

Topic 1: The IoT Node

WEEKS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 E

FORMAT	TOTAL DURATION	LOCATION	GROUP
In-person	07h 00m	Classroom (scheduled)	Normal

TOPICS: T1

METHODOLOGY: Lecture

L1: Wired Buses in the IoT Node

WEEKS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 E

FORMAT	TOTAL DURATION	LOCATION	GROUP
In-person	02h 20m	Laboratory	Reduced

TOPICS: T1

METHODOLOGY: Laboratory assignments

Topic 2: Design for Reliability and Low Power Consumption

WEEKS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 E

FORMAT	TOTAL DURATION	LOCATION	GROUP
In-person	08h 10m	Classroom (scheduled)	Normal

TOPICS: T2

METHODOLOGY: Lecture, Problem-solving class

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L2: Reliability and Power Consumption in IoT Nodes

WEEKS: 1 2 3 4 5 **6** 7 8 9 10 11 12 13 14 15 E

FORMAT	TOTAL DURATION	LOCATION	GROUP
In-person	02h 20m	Laboratory	Reduced

TOPICS: T2

METHODOLOGY: Laboratory assignments

Topic 3: Wireless Connectivity and Interoperability Standards in IoT

WEEKS: 1 2 3 4 5 **6** **7** **8** **9** 10 11 12 13 14 15 E

FORMAT	TOTAL DURATION	LOCATION	GROUP
In-person	09h 20m	Classroom (scheduled)	Normal

TOPICS: T3

METHODOLOGY: Lecture

L3: Matter Integration in ESP-IDF

WEEKS: 1 2 3 4 5 6 7 8 **9** 10 11 12 13 14 15 E

FORMAT	TOTAL DURATION	LOCATION	GROUP
In-person	02h 20m	Laboratory	Reduced

TOPICS: T3

METHODOLOGY: Laboratory assignments

Topic 4: Computing Paradigms in IoT

WEEKS: 1 2 3 4 5 6 7 8 9 **10** **11** 12 13 14 15 E

FORMAT	TOTAL DURATION	LOCATION	GROUP
In-person	04h 40m	Classroom (scheduled)	Normal

TOPICS: T4

METHODOLOGY: Lecture

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L4: Deployment of an IoT System for the Smart Home

WEEKS: 1 2 3 4 5 6 7 8 9 10 **11** 12 13 14 15 E

FORMAT	TOTAL DURATION	LOCATION	GROUP
In-person	02h 20m	Laboratory	Reduced

TOPICS: T4

METHODOLOGY: Laboratory assignments

L5: Integrated IoT Project

WEEKS: 1 2 3 4 5 6 7 8 9 10 11 **12** **13** 14 15 E

FORMAT	TOTAL DURATION	LOCATION	ASSESSMENT	WEIGHT	MINIMUM GRADE
In-person	07h 00m	Laboratory	Progressive	10%	0

TOPICS: T1 T2 T3 T4

METHODOLOGY: Work in group

ASSESSED OUTCOMES: KG1 HG2 CE12 CE15 CG3 CG5 CT3 CT4 CT1 HE13

L5: Group Presentation

WEEKS: 1 2 3 4 5 6 7 8 9 10 11 12 **13** 14 15 E

FORMAT	TOTAL DURATION	ASSESSMENT	WEIGHT	MINIMUM GRADE
Not in person, without teacher	01h 30m	Progressive	10%	0

TOPICS: T1 T2 T3 T4

METHODOLOGY: Group presentation

ASSESSED OUTCOMES: KG1 HG2 HE13 CE12 CE15 CG3 CG5 CT3 CT4 CG4 CT1

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Final Exam

WEEKS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 E

FORMAT	TOTAL DURATION	LOCATION	ASSESSMENT	WEIGHT	MINIMUM GRADE
In-person	02h 00m	Exam Classroom	Progressive, Global, Retake (Extraordinary)	60%	5

TOPICS: T1 T2 T3 T4

METHODOLOGY: Written exam

ASSESSED OUTCOMES: KE11 KG1 HG2 HE13 CE10 CE12 CE15 CG3 CG5 CT3 CT4 CT1

Final Practical Exam

WEEKS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 E

FORMAT	TOTAL DURATION	LOCATION	ASSESSMENT	WEIGHT	MINIMUM GRADE
In-person	01h 00m	Exam Classroom	Progressive, Global, Retake (Extraordinary)	40%	5

TOPICS: T1 T2 T3 T4

METHODOLOGY: Problem-solving exam

ASSESSED OUTCOMES: KG1 HG2 HE13 CE12 CE15 CG3 CG5 CT3 CT4 CT1

WEEKLY SCHEDULE

Assessment activity | Learning activity | • Week with activity | E Exam period

Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	E
Topic 1: The IoT Node	•	•														
L1: Wired Buses in the IoT Node			•													
Topic 2: Design for Reliability and Low Power Consumption			•	•	•											
L2: Reliability and Power Consumption in IoT Nodes						•										
Topic 3: Wireless Connectivity and Interoperability Standards in IoT						•	•	•	•							

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Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	E
L3: Matter Integration in ESP-IDF									•							
Topic 4: Computing Paradigms in IoT										•	•					
L4: Deployment of an IoT System for the Smart Home											•					
L5: Integrated IoT Project												•	•			
L5: Group Presentation													•			
Final Exam																•
Final Practical Exam																•

ASSESSMENT CRITERIA

General criteria

The course will be considered successfully completed when the student obtains a final grade of 5.0 or higher out of a maximum of 10 points.

The final grade will be calculated on the basis of the weighting of the different assessment activities established in this learning guide, taking into account, where applicable, the minimum marks required for each of them.

In addition, any assessment task or submission may be subject to an additional evaluation by the teaching staff in order to verify that it has been completed by the student without unauthorized external assistance.

Assessment criteria for the regular exam period. Progressive assessment

Assessment criteria

L5: Integrated IoT Project.
In lab activity L5, each laboratory group will develop an integrated project for an IoT environment. Each group will be required to submit the developed code via Moodle and complete a report on the work carried out. This activity will allow students to obtain **up to an additional 10%** toward the final grade.

L5: Group Presentation.
In lab activity L5, each laboratory group will prepare a **short video** presenting the development of the integrated IoT

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project, following the instructions provided by the teaching staff. This activity will allow students to obtain **up to an additional 10%** toward the final grade.

Final Exam.
The final exam will consist of a written examination. This test will account for **60%** of the final grade and will take place on the date established in the official examination schedule approved by the School Board. In order to pass, students must obtain a minimum mark of **5 out of 10**.

Final Practical Exam.
The final practical exam will consist of a written examination. This test will account for **40%** of the final grade and will take place on the date established in the official examination schedule approved by the School Board. In order to pass, students must obtain a minimum mark of **5 out of 10**.

Activities
- L5: Integrated IoT Project (10%)
- L5: Group Presentation (10%)
- Final Exam (60%)
- Final Practical Exam (40%)

Assessment criteria for the regular exam period. Global assessment

Assessment criteria

Final Exam.
The final exam will consist of a written examination. This test will account for **60%** of the final grade and will take place on the date established in the official examination schedule approved by the School Board. In order to pass, students must obtain a minimum mark of **5 out of 10**.

Final Practical Exam.
The final practical exam will consist of a written examination. This test will account for **40%** of the final grade and will take place on the date established in the official examination schedule approved by the School Board. In order to pass, students must obtain a minimum mark of **5 out of 10**.

Activities
- Final Exam (60%)
- Final Practical Exam (40%)

Assessment criteria for the retake (extraordinary) exam period

Assessment criteria

Final Exam.
The final exam will consist of a written examination. This test will account for **60%** of the final grade and will take place

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on the date established in the official examination schedule approved by the School Board. In order to pass, students must obtain a minimum mark of **5 out of 10**.

Final Practical Exam.
The final practical exam will consist of a written examination. This test will account for **40%** of the final grade and will take place on the date established in the official examination schedule approved by the School Board. In order to pass, students must obtain a minimum mark of **5 out of 10**.

Activities

- Final Exam (60%)
- Final Practical Exam (40%)

RESOURCES

Web

Moodle de la asignatura https://moodle.upm.es/titulaciones/oficiales

Bibliography

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ESP-IDF Programming Guide. Low Power Modes https://docs.espressif.com/projects/esp-idf/en/v6.0/esp32c6/api-guides/low-power-mode/index.html

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Documentación Espressif https://www.espressif.com/en/support/documents/technical-documents

SUSTAINABLE DEVELOPMENT GOALS

Industry, Innovation and Infrastructure

Responsible Consumption and Production

OTHER INFORMATION

The above 13-week schedule is indicative and will be adapted to the actual semester calendar in accordance with the guidelines issued by the Office of Academic Affairs.

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