ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

593000503 - Sensor Networks

DEGREE PROGRAMME

59AH - Master Universitario en Internet Of Things (iot)

ACADEMIC YEAR & SEMESTER

2019/20 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	593000503 - Sensor Networks
No of credits	4.5 ECTS
Type	Compulsory
Academic year ot the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	59AH - Master Universitario en Internet Of Things (iot)
Centre	59 - Escuela Tecnica Superior de Ingenieria y Sistemas de Telecomunicacion
Academic year	2019-20

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Fco. Javier Ramirez Ledesma	A4410	javier.ledesma@upm.es	Sin horario. TBD
Hugo Alexer Parada Gelvez	A4423	hugoalexer.parada@upm.es	Sin horario. TBD
Ruben Diego Martinez (Subject coordinator)	A4411	ruben.de.diego@upm.es	Sin horario. TBD

Miguel Chavarrias Lapastora	A4406	miguel.chavarrias@upm.es	Sin horario. TBD
Eduardo Juarez Martinez	A4204	eduardo.juarez@upm.es	Sin horario. TBD
Eduardo Barrera Lopez De Turiso	A4203	eduardo.barrera@upm.es	Sin horario. TBD
Sergio Esquembri Martinez	A4206	s.esquembri@upm.es	Sin horario. TBD

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

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

- Embedded Platforms And Communications For Iot

3.2. Other recommended learning outcomes

- Programming and debugging using the C++ or Java language

4. Skills and learning outcomes *

4.1. 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

CB10 - 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.

CE.02 - Diseñar y desarrollar redes de sensores integrando nodos heterogéneos con diferentes sistemas de comunicación inalámbricas para desarrollar aplicaciones IoT

CE.03 - Programar dispositivos móviles en diferentes escenarios de aplicación en IoT en las que se recopilan datos del entorno a través de los sensores integrados en los dispositivos móviles.

CE.13 - Analizar el uso de dispositivos y servicios IoT en dominios de aplicación específicos y seleccionar los dispositivos más adecuados para el ecosistema IoT

CG01 - Los alumnos demostrarán tener una visión del estado actual, las necesidades y los problemas que se plantean en el mundo de la IoT, así como de las arquitecturas y estándares más utilizados

CG02 - Los alumnos serán capaces de aplicar métodos y tecnologías avanzadas que les permitan abordar necesidades y problemas en aplicaciones IoT

CT.01 - Capacidad de uso de la lengua inglesa para el trabajo en contextos internacionales

CT.02 - Capacidad para el trabajo en grupo y dirigir, organizar y supervisar equipos multidisciplinares.

4.2. Learning outcomes

RA37 - To build custom sensor nodes tailored to the processing requirements/needs of a given problem.

RA38 - To establish the criteria for the selection and integration into a hardware platform of the required wireless technologies and communication protocols for building IoT applications

RA39 - To combine the development tools for the integration of the components of a sensor network in IoT environments

* 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.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

A sensor network is composed of several sensor nodes that communicate among them to build up homogeneous or heterogeneous networks, aiming at sensing information and acting accordingly in a wide physical environment. This course tackles the configuration and implementation of this type of networks, studying the most common technologies, protocols and architectures used. To do so, the building process of custom, high-performance sensor nodes and advanced wireless technologies for IoT are analyzed, considering performance and power consumption factors.

5.2. Syllabus

1. General Communication Model Introduction
   1.1. Context description
   1.2. Challenges
   1.3. Existing models
   1.4. Communications commercial IoT solutions overview
2. Low-power wide-area wireless communications
   2.1. Lora/LoraWAN
   2.2. Sigfox
   2.3. Others (LTE-MTC, NB-IoT, Weightless SIG...)
3. Network interoperability
   3.1. Interoperability models.
   3.2. Gateways
4. Short-range wireless communications
   4.1. IEEE 802.15.4 ZigBee and 6LoWPAN
   4.2. Others (XBee, Bluetooth...)
5. Sensor networks practical design methodology
   5.1. Processing requirements
   5.2. Node type and platform selection
   5.3. Network type selection
   5.4. Interoperability requirements
   5.5. Development tools
6. Project 1. Embedded wireless sensor design and integration use case
7. Project 2. Short-range wireless communications and interoperability use case

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Other face-to-face activities	Assessment activities
1	**Lesson1. General Communication Model Introduction** Duration: 02:00 **Lesson 2. Low-power wide-area wireless communications** Duration: 03:30			
2	**Lesson 3. Network interoperability** Duration: 02:00	**Project 1. Embedded wireless sensor design and integration use case** Duration: 01:30		
3		**Project 1. Embedded wireless sensor design and integration use case** Duration: 03:00		**Multiple Choice Test 1** Continuous assessment Duration: 00:30
4		**Project 1. Embedded wireless sensor design and integration use case** Duration: 03:30		
5		**Project 1. Embedded wireless sensor design and integration use case** Duration: 02:00		
6	**Lesson 4. Sort-range wireless communications** Duration: 01:00			**Project 1. Embedded wireless sensor design and integration use case assessment** Continuous assessment Duration: 02:30
7	**Lesson 4. Sort-range wireless communications** Duration: 02:30	**Project 2. Short-range wireless communications and interoperability use case assessment** Duration: 03:00		
8	**Lesson 5. Sensor networks practical design methodology** Duration: 01:30	**Project 2. Embedded wireless sensor design and integration use case** Duration: 02:00		
9	**Lesson 5. Sensor networks practical design methodology** Duration: 02:00	**Project 2. Embedded wireless sensor design and integration use case** Duration: 01:30		

10		**Project 2. Embedded wireless sensor design and integration use case** Duration: 03:00		**Multiple Choice Test 2** Continuous assessment Duration: 00:30
11		**Project 2. Embedded wireless sensor design and integration use case** Duration: 02:00		**Project 2. Short-range wireless communications and interoperability use case assessment** Continuous assessment Duration: 04:00 **Multiple choice exam** Final examination Duration: 01:00 **Course projects exam** Final examination Duration: 04:00
12				
13				
14				
15				
16				
17				

The independent study hours are training activities during which students should spend time on individual study or individual assignments.

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 subject schedule is based on a previous theorical planning of the subject plan and might go to through experience some unexpected changes along throughout the academic year.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
3	Multiple Choice Test 1		Face-to-face	00:30	10%	0 / 10	CT.01 CE.13 CB10 CG01
6	Project 1. Embedded wireless sensor design and integration use case assessment		Face-to-face	02:30	40%	5 / 10	CT.01 CT.02 CE.13 CB10 CE.03 CG01 CB06 CG02 CE.02
10	Multiple Choice Test 2		Face-to-face	00:30	10%	0 / 10	CT.01 CE.13 CB10 CG01
11	Project 2. Short-range wireless communications and interoperability use case assessment		Face-to-face	04:00	40%	5 / 10	CT.01 CT.02 CE.13 CB10 CE.03 CG01 CB06 CG02 CE.02

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
11	Multiple choice exam		Face-to-face	01:00	20%	0 / 10	CT.01 CE.13 CB10 CG01

11	Course projects exam		Face-to-face	04:00	80%	5 / 10	CT.01 CT.02 CE.13 CB10 CE.03 CG01 CB06 CG02 CE.02

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Course projects exam		Face-to-face	04:00	80%	5 / 10	CT.01 CT.02 CE.13 CB10 CE.03 CG01 CB06 CG02 CE.02
Multiple choice exam		Face-to-face	01:00	20%	0 / 10	CE.13 CB10 CT.01 CG01

7.2. Assessment criteria

The final mark for each student in this course will be a number between 0 and 10 points. The course is passed if the mark is equal or above 5 points.

Continuous Assessment

The continuous assessment will be carried out based in the following components:

- Two multiple choice exams, Test 1 and Test 2, evaluating:
  - Test 1: Lessons 1, 2 and 3 and the preliminary concepts used in Project 1.
  - Test 2: Lessons 4 and 5 and the preliminary concepts used in Project 2.

- Two projects:
  - Project 1: Embedded wireless sensor design and integration use case. Students will have to integrate the Platform use case developed in the subject Embedded Platforms and Communications for IoT in the previous two-month period.
  - Project 2: Short-range wireless communications and interoperability use case.

The course grade will be composed of the following elements:

- Multiple choice exams: 20% (2 points)
  - Test 1: 10% (1 points)
  - Test 2: 10% (1 points)

- Assessment of the course Projects: 80% (8 points)
  - Project 1: 40% (4 points)
  - Project 2: 40% (4 points)

Final examination

The final examination will consist of the following components:

- Course projects exam: it is a written and a practical exam of the two developed projects.
- A multiple choice exam, evaluating all the contents of the two continuous assessment multiple choice tests (Test 1 and Test 2).

The grade will be composed of the following elements:

- Multiple choice exam: 20% (2 points)
- Course projects exam: 80% (8 points)

Referred (re-sit) examination

The referred (re-sit) examination will consist of the same components and weights as those of the final examination.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Personal computer	Equipment	Personal computer with Internet connection for carrying out practical exercises.
Subject Moodle based web site	Web resource	UPM web site based on Moodle where short technical documents, bibliographic resources, practical exercises instructions and subject slides will be published. Several educational forums will be also available for discussions.

Networked sensors (IoT Platform)	Equipment	The sensors and communication platform previously studied in the subjects "Embedded systems and IoT devices"
Hossam Mahmoud y Ahmad Fahmy, Wireless Sensor Networks	Bibliography	Hossam Mahmoud & Ahmad Fahmy, "Wireless Sensor Networks", Springer Science, 2016
Wireless Sensor Networks, Ibrahiem M. El Emary; S. Ramakrishnan	Bibliography	Wireless Sensor Networks, Ibrahiem M. El Emary; S. Ramakrishnan, CRC Press, 2014

9. Other information

9.1. Other information about the subject

The information contained in this document is of an orientative nature. Thus, it is subject to change due to errors, omissions or if the circumstances occurring during the course duration advise to do so.

10. Adendas

- The following changes must be carried out in table 6.1 Subject Schedule (pages 5 and 6), column “Face-to-face laboratory activities”: a) In week 7 the text “Short-range wireless communications and interoperability use case assessment” must be replaced by “Short-range wireless communications and interoperability use case” b) In weeks 8, 9, 10 and 11 the text: “Embedded wireless sensor design and integration use case” must be replaced by “Short-range wireless communications and interoperability use case”