

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

593000510 - Cloud Computing For Iot

DEGREE PROGRAMME

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

ACADEMIC YEAR & SEMESTER

2024/25 - Semester 2

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1. Description

1.1. Subject details

Name of the subject	593000510 - Cloud Computing For Iot
No of credits	4.5 ECTS
Type	Compulsory
Academic year of the programme	First year
Semester of tuition	Semester 2
Tuition period	February-June
Tuition languages	English
Degree programme	59AH - Master Universitario en Internet Of Things (Iot)
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 *
Jessica Diaz Fernandez (Subject coordinator)	1119	yesica.diaz@upm.es	Sin horario. Sin horario
Fernando De Mingo Lopez	1122	fernando.demingo@upm.es	Sin horario. Sin horario

* 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

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- Programming languages
- Version control

4. Skills and learning outcomes *

4.1. Skills to be learned

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

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.12 - Analizar las tecnologías de virtualización y el diseño de servicios basados en dichas tecnologías incluyendo contenedores y servicios en la nube

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

CG03 - Los alumnos demostrarán tener las destrezas necesarias para integrar y aplicar los conocimientos adquiridos de forma que puedan desarrollar soluciones innovadoras y servicios IoT en general

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

RA17 - To evaluate the main strengths and weaknesses among different technologies and virtualization and Cloud platforms

RA18 - To design IoT application architectures that meet flexibility, scalability and performance requirements using technologies and virtualization and Cloud platforms

RA19 - To develop applications for IoT using the main support frameworks for software construction

RA20 - To use the most important Cloud platforms to develop and deploy IoT 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.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

The exponential growth of data generated by IoT-based systems is a challenge. Cloud computing offers self-provisioning infrastructure and platform, which makes it the natural candidate for supporting the needs of IoT-based systems, i.e. data processing, data storing, and data analysis. Cloud services process such data satisfying flexibility, scalability and performance requirements. This course is focused on the study of cloud computing architectures and emerging technologies and platforms applied to IoT systems, such as containerization, serverless, and DevOps culture and automation practices (specifically, Continuous Integration and Continuous Delivery). The course addresses both the theoretical basis and different application scenarios.

5.2. Syllabus

1. DevOps on the Internet of Things

- 1.1. Application Life-cycle Management
- 1.2. DevOps definition. Successful industrial cases
- 1.3. DevOps culture & Practices
- 1.4. Continuous Integration, Continuous Delivery, and Continuous Deployment
- 1.5. DevOps on IoT. Challenges
- 1.6. Azure DevOps

2. Virtualization & Containerization

- 2.1. Virtualization. Concept
- 2.2. Virtualization. Key features. Advantages and disadvantages
- 2.3. Software for virtualization
- 2.4. Containerization. Concept
- 2.5. Containerization. Key features. Advantages and disadvantages
- 2.6. Software for containerization
- 2.7. Software for container orchestration
- 2.8. Serverless

3. Cloud computing

- 3.1. Overview. Cloud Computing concept
- 3.2. Cloud service model: IaaS, PaaS, SaaS
- 3.3. Cloud deployment model: private cloud, public cloud, hybrid cloud
- 3.4. Cloud architecture and quality attributes
- 3.5. Trends & Challenges & Drawbacks
- 3.6. Cloud Computing on IoT
- 3.7. Cloud providers: Microsoft Azure, Google Cloud, Amazon AWS, etc.
- 3.8. Azure Fundamentals & Services: Azure Virtual Machines & Azure Containers

4. IoT Cloud services: Microsoft Azure

- 4.1. IoT Cloud Reference Architectures

4.2. Azure IoT Reference Architecture & Services

4.3. Azure IoT, Azure Storage, Azure Stream Analytics, Azure Functions, App Service, Azure Cache, Power BI, others

5. Edge Computing

5.1. Overview. Edge computing concept

5.2. Evolution of IoT Reference Architecture: Continuum Edge

5.3. Azure IoT Edge

5.4. Continuous integration & Continuous Delivery using Azure IoT Edge

6. Schedule

6.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	Syllabus presentation, guidelines and software Duration: 01:00 Lecture 1. DevOps on the IoT Duration: 02:30 Lecture			
2		Exercise DevOps on IoT Duration: 01:00 Inverted classroom Exercise Azure DevOps Pipelines Duration: 02:30 Laboratory assignments		
3	2. Virtualization Duration: 01:30 Lecture 2. Containerization Duration: 02:00 Lecture	Exercise: virtual machines Duration: 02:00 Laboratory assignments		[Progressive Evaluation] Exercise1 Virtual Machines and Containers (RA18) Individual work Progressive assessment Not Presential Duration: 00:00
4	2. Serverless Duration: 01:00 Lecture	Exercise: containers Duration: 02:30 Laboratory assignments		
5	3. Cloud Computing Duration: 02:00 Lecture	Exercise Azure Duration: 01:30 Laboratory assignments		
6	3. Microsoft Azure Duration: 01:00 Lecture	Exercise Azure Duration: 02:30 Laboratory assignments		[Progressive Evaluation] Exercise2 Cloud IoT (RA18, RA20) Individual work Progressive assessment Not Presential Duration: 00:00
7	5. Cloud IoT services (Azure IoT) Duration: 02:00 Lecture	Exercises Azure IoT Duration: 03:30 Laboratory assignments		
8	5. Edge Computing Duration: 01:00 Lecture	Exercises Azure IoT Edge Duration: 02:30 Laboratory assignments		
9		Exercises Azure IoT Edge Duration: 03:30 Laboratory assignments		

10		Lab assignment: development and deployment of an IoT app Duration: 03:30 Laboratory assignments		[Progressive Evaluation] Oral presentation of the lab assignment (RA17) Group presentation Progressive assessment Presential Duration: 02:00
11				
12				
13				
14				
15				
16				
17				[Global Evaluation] Verification of Exercise1 Virtual Machines and Containers (RA18) Individual work Global examination Not Presential Duration: 00:00 [Global Evaluation] Verification of Exercise2 Cloud IoT (RA18, RA20) Individual work Global examination Not Presential Duration: 00:00 [GlobalEvaluation] Verification Oral presentation of the lab assignment (RA17) Group presentation Global examination Presential Duration: 02:00 [Global Evaluation] Report of the Lab assignment (RA18, RA19, RA20) Group work Progressive assessment and Global Examination Not Presential Duration: 00:00 [Global Evaluation] Test (RA17) Written test Progressive assessment and Global Examination 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.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
3	[Progressive Evaluation] Exercise1 Virtual Machines and Containers (RA18)	Individual work	No Presential	00:00	10%	/ 10	CG02 CE.12
6	[Progressive Evaluation] Exercise2 Cloud IoT (RA18, RA20)	Individual work	No Presential	00:00	10%	/ 10	CG02 CE.12
10	[Progressive Evaluation] Oral presentation of the lab assignment (RA17)	Group presentation	Face-to-face	02:00	20%	/ 10	CB09 CB10 CT.01 CT.02 CG03
17	[Global Evaluation] Report of the Lab assignment (RA18, RA19, RA20)	Group work	No Presential	00:00	40%	5 / 10	CB10 CG02 CE.12 CT.02 CG03
17	[Global Evaluation] Test (RA17)	Written test	Face-to-face	01:00	20%	5 / 10	CE.12

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	[Global Evaluation] Verification of Exercise1 Virtual Machines and Containers (RA18)	Individual work	No Presential	00:00	10%	/ 10	CG02 CE.12
17	[Global Evaluation] Verification of Exercise2 Cloud IoT (RA18, RA20)	Individual work	No Presential	00:00	10%	/ 10	CG02 CE.12
17	[Global Evaluation] Verification Oral presentation of the lab assignment (RA17)	Group presentation	Face-to-face	02:00	20%	/ 10	CB09 CB10 CT.01 CT.02 CG03
17	[Global Evaluation] Report of the Lab assignment (RA18, RA19, RA20)	Group work	No Presential	00:00	40%	5 / 10	CB10 CG02 CE.12 CT.02 CG03

17	[Global Evaluation] Test (RA17)	Written test	Face-to-face	01:00	20%	5 / 10	CE.12
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7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
[Referred Exam] Test (RA17)	Written test	Face-to-face	01:00	40%	5 / 10	CE.12
[Referred exam] Report of the Lab assignment (RA18, RA19, RA20)	Individual work	Face-to-face	00:00	40%	5 / 10	CE.12 CB10 CG02 CG03
[Referred Exam] Oral presentation of the lab assignment	Individual presentation	Face-to-face	01:00	20%	5 / 10	CT.01 CB09 CB10 CG03

7.2. Assessment criteria

GLOBAL EVALUATION

Final Grade = $0.1 \times \text{Exercise1} + 0.1 \times \text{Exercise2} + 0.2 \times \text{Test} + 0.4 \times \text{Report of the Lab assignment} + 0.2 \times \text{Oral presentation of the Lab assignment}$

To pass the course a grade of 5 out of 10 must be obtained.

Note that exercises 1 & 2 and the oral presentation of the Lab assignment are mandatory activities to be performed **during** the course (the teaching period).

Previous grades are stored until the referred (re-sit) examination of the current course.

REFERRED EXAMINATION

Final Grade = $0.4 \times \text{Test} + 0.4 \times \text{Report of the Lab assignment} + 0.2 \times \text{Oral presentation of the Lab assignment}$

To pass the course a grade of 5 out of 10 must be obtained.

* The transversal competence / soft skill CT.01 (Capacidad de uso de la lengua inglesa para el trabajo en contextos internacionales) is evaluated through the oral presentation of the lab assignment (10% of the score).

** The transversal competence / soft skill CT02 (Capacidad para el trabajo en grupo y dirigir, organizar y supervisar equipos multidisciplinares) is evaluated through the realization of the lab assignment (10% of the score). The report should include an effort table (hours per student). Also the use of an agile project management tool (team and tasks management) (e.g. trello.com) from which you must capture your status in several milestones throughout the implementation of the practice.

**** The solutions to the tests will not be published due to the limited degree of variability of the questions.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Cloud Computing	Bibliography	Cloud Computing By: Lizhe Wang; Rajiv Ranjan; Jinjun Chen; Boualem Benatallah Publisher: CRC Press Pub. Date: December 21, 2017 Print ISBN-13: 978-1-4398-5641-3
The Docker Book	Bibliography	THE DOCKER BOOK CONTAINERIZATION IS THE NEW VIRTUALIZATION https://dockerbook.com/
Microsoft Azure Essentials: Fundamentals of Azure	Bibliography	Microsoft Azure Essentials: Fundamentals of Azure, Second Edition Michael S. Collier and Robin E. Shahan

Microsoft Azure Essentials: Azure Web Apps for Developers	Bibliography	Microsoft Azure Essentials: Azure Web Apps for Developers
Aula con dispositivos audiovisuales	Equipment	
Laboratorios con recursos informáticos para la realización de las prácticas	Equipment	
Moodle	Web resource	https://moodle.upm.es/titulaciones/oficiales