Universidad de Alcalá

TEACHING GUIDE

Expansion of Operating Systems

Degree in
Telematics Engineering

Universidad de Alcalá

Academic Year 2021/2022

4th Year - 1st Semester

Approved by the School Board on July 6, 2021

TEACHING GUIDE

Course Name:	**Expansion of Operating Systems**
Code:	**380015**
Degree in:	**Telematics Engineering**
Department and area:	**Automática** **Computer Architecture and Technology**
Type:	**Optional (Oriented)**
ECTS Credits:	**6.0**
Year and semester:	**4th Year, 1st Semester**
Teachers:	Óscar García Población.
Tutoring schedule:	Tutoring and office hours will be published on the presentation day
Language:	Spanish/English Friendly

1. COURSE SUMMARY

This guide is a tool that will allow the student to know the contents that compose the subject, the competences that will be acquired with its study, the distribution in time of the different activities, and the requirements to pass the subject as well as other information of interest.
The course of Expansion of Operating Systems is taught in the first four-month period of the fourth year of the Degree in Telematics Engineering. It is an optional course that delves into the role of operating systems as part of the fundamental structure of information systems. It has been assigned 6 ECTS credits, with an attendance of four hours per week and its content is distributed in three blocks.
The first block will be dedicated to classical operating systems administration, starting with the role of the operating system as the basis for the administration and configuration of computer systems. We will begin by locating the role of the system administrator in the current context of organizations. We will go on to identify some of the more common responsibilities, and introduce a new discipline that has been attributed to administrators in a noticeable way in recent years: development operations, or devops. This will be followed by a review of basic techniques and tools for managing computer systems, methods for obtaining system reports, and strategies for automating repetitive tasks. At this point, the programming of command interpreters will be studied in depth, since this is one of the most powerful tools for the automation of system administration tasks, as well as for the provision of various services. Bourne's shell (BASH) will be used as a shell because it is one of the most widespread in the Unix world. We will end this section by discussing identity management and identity authentication, as well as some basic aspects of file system access control.
During the last decade, technologies based on hardware virtualization have made a significant impact on the way computer systems are conceived, designed and built. In this second block we will study the fundamental building blocks of cloud technology, starting with computing services, followed by storage and networking and communications. We will also include some elements related to security, managed services and the automation of some of the typical operations, such as provisioning and deployment. We will end this block by analyzing how cloud-based environments influence current software development, extending some known concepts of distributed systems to concepts such as serverless systems and microservices-based software architectures.
In the third block we will study another of the most outstanding outcomes of virtualization, which is container technology, using Docker containers as an example. In addition to presenting them at a conceptual level and describing in detail most of their operations, we will show how these containers can be combined to form complex software architectures. We will also discuss their role during the software development stages and how to deploy containers in productive environments.

Prerequisites and Recommendations.

This course builds on much of the knowledge acquired during the previous courses, in particular in the Operating Systems and Programming courses. It is therefore highly recommended to have passed these subjects before taking the Operating Systems Extension course.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills, which are defined in the Section 3 of the Annex to the Orden CIN/352/2009:

en_TR2 - Knowledge of basic subjects and technologies that enables to learn new methods and technologies, as well as to provide versatility that allows adaptation to new situations.

en_TR3 - Aptitude to solve problems with initiative, decision making, creativity, and to communicate and to transmit knowledge, skills and workmanship, comprising the ethical and professional responsibility of the activity of the Technical Engineer of Telecommunication.

Professional Skills

This course contributes to acquire the following professional skills, which are defined in the Section 5 of the Annex to the Orden CIN/352/2009:

en_CTE3 - Ability to build, operate and manage telematic services using analytical planning, sizing and analysis tools.

en_CTE6 - Ability to design network architectures and telematic services.

en_CTE7 - Programming capacity of services and telematic applications, in network and distributed.

Learning Outcomes

After succeeding in this subject the students will be able to:

RA1. Manipulate tools and procedures to efficiently perform the tasks of the administration.
RA2. Use the procedures and techniques related to the management of users of computer services.
RA3. Understand the basics of the mass storage of information.
RA4. Adapt the knowledge related to mass storage of information for its use in administration tasks
RA5. Install and configure in a basic way some of the most universal computer services.
RA6. Demonstrate awareness of the responsibility of engineering practice, social and environmental impact, and commitment to professional ethics, accountability, and standards of engineering practice.

3. CONTENTS

Contents Blocks	Total number of hours
BLOCK 1: Introduction to administration and basic tools. Introduction to the administration of operating systems. Business and organizational scope. Basic administration tools: Initial shell concepts. Redirections (input, output, errors). Communication between processes: pipes and signals. Process management commands: ps, pstree, time, who. Background execution: &, jobs, fg, bg. Filter concept. Filters wc, cut, paste, head, tail, tr, sort, uniq, tee and grep. Regular expressions: definition, sets, ranges and quantifiers. AWK, basic operation, rule types, pattern types, flow control, predefined functions, arrays. Sed flow editor. Find command. Other interesting commands: date, cal, diff, cmp, comm, iconv. Introduction to shell scripts. Modes of execution of a script. Expansion of variables. Parameter passing. Language elements. Control structures. List and vector processing. Input and output. Redirections. User management in Linux/Unix. Users and groups and their role in operating systems. Identification and Authentication, UID concept. Relationship with the file system. The /etc/passwd file. Detailed study of authentication using shared secrets. Shadow password system. Seed/password encryption with MD5. mkpasswd command. Manual user registration in the system. Adduser and useradd scripts. Scripts for mass registrations. Problems with commands that must be executed with administrator privileges: passwd and the SUID bit. Other scripts for user and group management: deluser, addgroup, delgroup. Aging and other password policies. Chage command. Storage and storage device management. storage devices. Information storage mechanisms: raw data, file cabinets and file systems. Block mode devices, major and minor number. Archivers: tar. Meta information, modifiers c: create, v: verbose, f: file, t: test, x: eXtract. Compression of stored data: modifiers z: gzip, j: bzip. File systems. Creating a file system with mkfs, modifier -t. Mounting a file system. Mount command. dd command. Using the /dev/zero device to create images. Mounting images, -o loop RAID and LVM	4S, 16h hours
BLOCK 2: Cloud technologies Introduction to cloud technologies. Google Cloud as an example of cloud infrastructure. Ways of interacting with the cloud. Computing services. Concept of IaaS and PaaS. Usage scenarios. IaaS in GCP: Compute Engine. Virtual private clouds. Introduction to networking and communications security. PaaS, description and alternatives: Cloud Functions, App Engine and Cloud Run. Managed storage services. Introduction to Cloud Storage. Bucket properties. Usage scenarios. Relational databases managed with Cloud SQL. In-memory databases: Redis. Custom networking and security. Task automation in GCP.	4S, 16h hours

BLOQUE 3: Tecnologìa de contenedores. Introduccioìn a la tecnologìa de contenedores. Diferencias con la virtualizacioìn del hardware y con otras teìcnicas de virtualizacioìn. Introduccioìn a Docker. Construccioìn de una imagen baìsica. Contenedores con procesos interactivos. Construccioìn de imaìgenes complejas. Operaciones con las imaìgenes. Publicacioìn de imaìgenes. Ejecucioìn de servicios dentro de contenedores. Los contenedores y las redes. Volumìenes de datos y volumìenes compartidos. Docker como entorno de desarrollo. Orquestacioìn de contenedores con docker-compose, redes internas, servicio de resolucioìn de nombres y servicios. Introduccioìn a Kubernetes. Servicios cloud relacionados: ejemplo de Google Cloud Run y Google Kubernetes.	4S, 16h hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	58 hours (56 hours on-site +2 exams hours)
Number of hours of student work:	92
Total hours	150

4.2. Methodological strategies, teaching materials and resources

Classroom	• **Theory and lab classes**: these classes will be given in the laboratory. The professor will present the theoretical concepts and will then guide the students through their practical application on a Unix system set up for this purpose in the laboratory. • **Resolution of practical cases:** during the laboratory sessions several problems susceptible of being solved by means of techniques exposed in class will be presented. The application of these techniques to solve the problem will be guided. • **Presentation of assigments and works**: students will have to present to their classmates and to the teacher assignments and projects that they have carried out individually or in small groups. The presentations will make use of the appropriate multimedia techniques. • **Partial tests:** during the development of the course the professor will propose several partial tests to review the acquisition of knowledge and its application.
Individual work	• **Readings** • **Activities**: exercises, concept maps, exemplifications, information search. • **Participation in forums and activities**, generally through the teaching platform of the subject.
Tutoring	The tutoring may be either in groups or individually. During the tutoring sessions the tutor will be able to evaluate the acquisition of the competencies and will review the reports provided by the students on the work assigned.
Resources	The materials for the preparation of the face-to-face sessions, as well as the activities to be carried out by the student individually, can be found in the Virtual Classroom of the UAH. The operation of this teaching tool will be detailed in the presentation class of the course. It will explain, among other things, the way in which students will register in the general message forum, which will be the usual mechanism of communication with students. For each activity, the tutor will provide a series of references, both bibliographical, which can be consulted in the library of the Polytechnic School, and of any other nature. For those activities that require it, the tutor will indicate how to plan such activity as well as the deliverables that should result from the realization of the same.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary call

Continuous assesstment procedure

Continuous assessment evaluates the development of competencies throughout the learning process of the subject by means of a series of formative tests distributed throughout the course, which allow the student to approach the subject progressively.

This form of evaluation guarantees early feedback in the student's learning process and allows the tutors, coordinators and other elements of the Quality Assurance System to make a global follow-up, with the possibility of acting in case indicators or specific situations make it advisable.
The evaluation of the part related to the internship will be carried out at the end of the corresponding block.

Extraordinary call for exams

The procedure will be the same as the one described for the Non-continuous assessment in the ordinary call.

5.2. EVALUATION

Assessment criteria

The following assessment criteria will be taken into account to verify whether the student has achieved the expected objectives:

CE1. Knows and knows how to apply the basic tools offered by Shell for system administration.

CE2. Develops programs for the Shell that allow automating maintenance and monitoring tasks of systems.

CE3. Knows how to register users and groups in local systems as well as in centralized systems.

CE4. Knows the procedures to integrate storage media in a computer system.

CE5. Is able to install, configure and start up a computer service.

CE6. Is able to develop own production works, properly citing the sources when such works are based on third party material, according to the criteria of correct professional ethics in the practice of engineering.

CE7. Is able to define and operate managed services typical of cloud environments.

CE8. Understands the general aspects of cloud technologies, in particular those related to computing, storage and communications provisioning services. In addition, he/she is able to assemble simple architectures combining these elements for the provision of services.

CE9. Understands container technology, distinguishes between containers and container images, knows how to build simple images and publish their services through basic network mechanisms.

CE10. Is able to orchestrate the services provided by several containers to synthesize complex architectures.

CE11. Is able to assemble software development environments using containers.

Grading instruments

Continuous assessment

Students will be assessed on a continuous assessment basis throughout the course. Their performance will be assessed by their work, knowledge and skills acquired and the improvement of their learning process. The methods to be used will consist of a series of continuous assessment activities proposed by the tutor, at least one per content block. In global, these activities will suppose 100% of the grading of the student, not supposing any of them more than 40% of the final grading of the subject. These activities include:

PEI: Theoretical-practical tests of continuous assessment about the theoretical contents of the subject.

E1: Research work and configuration of services previously agreed with the tutor of the subject.

Non-continuous assessment and Extraordinary assessment

Students who have been granted the Non-continuous assessment will be graded through the following activities:

E1: Research work and configuration of services previously agreed with the tutor of the subject.

PEF: Theoretical-practical assessment test about the theoretical contents of the course.

Evaluation criteria

Continuous assessment

Competence	Learning outcome	Assessment criteria	Grading instrument	Grading weight
TR2, TR3, CTE7	RA1, RA2, RA3, RA4	CE1-4, CE6	PEI1, E1	33%
TR2, TR3, CTE6, CTE3	RA2-6	CE6-8	PEI2, E1	33%
TR2, TR3, CTE7	RA5, RA6	CE9-11, CE6	PEI3, E1	33%

Non-continuous assessment and extraordinary call

Competence	Learning outcome	Assessment criteria	Grading instrument	Grading weight
TR2, TR3, CTE3, CTE6, CTE7	RA1-6	CE1-11	PEF, E1	100%

According to Article 34 of the Regulations for the Assessment of Learning, regarding Originality of Papers and Tests:

1. The University will inform students that plagiarism is a practice contrary to the rules and principles governing university education.
2. The University will provide students with the necessary training for the preparation of papers or other assessment tests in order to teach them to handle and cite the sources used, as well as to develop and put into practice the required skills.
3. Plagiarism is understood as the copying of texts without citing the source and giving them as their own elaboration and will automatically lead to the grading of failure (0) in the work or tests in which it has been detected. The tutor who notices signs of plagiarism in the assessment papers or tests presented to him/her shall report this fact to the dean or director of the center within a maximum period of two days, so that he/she may proceed, if necessary, to inform the Rector in case it could constitute a disciplinary infraction or a crime.
4. The teaching guides may include the provision that the student must sign in the work and materials submitted for the assessment of their learning an explicit statement in which he/she assumes the originality of the work, understood in the sense that he/she has not used sources without properly citing them.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

Unix y Linux: Guìla Praìctica. 3a Edicioìn.

Sebastiaìn Saìnchez Prieto y Oìscar Garciìa Poblacioìn. Editorial RA-MA.

The Google Cloud documentation

https://cloud.google.com/docs

The Docker project documentation

https://docs.docker.com/

6.2. Additional Bibliography

Advanced Bash-Scripting Guide: An in-depth exploration of the art of shell scripting

Mendel Cooper
The Linux Documentation Project.

Essential System Administration, 3rd Edition

Tools and Techniques for Linux and Unix Administration Æleen Frisch

O'Reilly Media

Linux administration handbook

Evi Nemeth, Garth Snyder, Trent R. Hein,

Disclosure Note

The University of Alcalá guarantees to its students that, if due to health requirements the competent authorities do not allow the total or partial attendance of the teaching activities, the teaching plans will achieve their objectives through a teaching-learning and evaluation methodology in online format, which will return to the face-to-face mode as soon as these impediments cease.