CLOUD COMPUTING

Grado en Computación e Inteligencia Artificial / Bachelor in Computer Science and Artificial Intelligence BCSAI SEP-2025 CC-N-CSAI.2.M.A

Area Computer Science

Number of sessions: 15

Academic year: 25-26

Degree course: SECOND

Number of credits: 3.0

Semester: 1º

Category: COMPULSORY

Language: English

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EDUARDO RODRÍGUEZ LORENZO

Eduardo Rodriguez Lorenzo is Senior Manager at NETSCOUT and Adjunct Professor at IE School of Science and Technology. He is a technologist specializing in Telecommunication Networks, Cybersecurity, Software Architecture, Data Engineering and Analytics.

He studied at UPM (Universidad Politécnica de Madrid), King's College London and London University.

At NETSCOUT, he leads a global team of Data and Network Engineers with a strong focus on Network Service Assurance, Cybersecurity, Data Engineering and Analytics.

He has gained broad international experience delivering high-value Consulting Services (Customer Experience & Customer Journeys, Business Intelligence, Service Assurance, Data Monetization, Process Engineering...) and Data-driven Solutions (Cloud & Backend Architecture, Data Feeds, Database, Dashboard, Interaction & Visualisation Design) to global Enterprises and Communication Service Providers. He has played an active role in the launch, measurement and optimisation of Mobile Networks for various top international Telcos.

He is a member of the Spanish Charter of Telecommunications Engineers (COIT) where he is an active member of the Telecommunications Policy and Regulation Group and the Digital Transformation Group.

His main interests include Disruptive Technologies, Data Engineering Architectures, Networks, Distributed Systems and Graph technology.

He joined IE University in 2020 as an Adjunct Professor, teaching various subjects on Data Engineering, Technology and Cybersecurity. He is also the Academic Director for IE Impact Technology.

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Office Hours

Office hours will be on request. Please contact at:

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SUBJECT DESCRIPTION

Cloud computing is one of the most significant technology developments of our lifetimes. It has made many new businesses possible and presents an opportunity to large enterprises to innovate. It allows enterprises to move from CAPEX to OPEX consumption-based model and benefit from high availability, scalability, elasticity and agility, while improving IT resources and reducing expenses and development time, thanks to a pay-as-you-use model.

This is a practical course on Cloud Computing designed to provide Computer Scientists with business, architectural and hands-on experience to tackle small to medium-size Cloud projects. All Cloud paradigms are considered and studied (SaaS, PaaS, IaaS), and Microsoft Azure and Amazon Web Services (AWS) are the platforms of choice to demonstrate concepts and cloud design patterns.

A solid foundation on enabling technologies is provided, including Virtualization, Containers and Automation technologies for Linux systems.

Students will work in Groups to implement an end-to-end Cloud Architecture. This project becomes the common thread of all sessions, and allows students to immediately apply the knowledge acquired to a real-world scenario.

LEARNING OBJECTIVES

- Understanding the historical evolution of Data Centers that led to the Cloud revolution
- Gain knowledge of cloud architectures and service, delivery, and business models.
- Acquire basic familiarity with Microsoft Azure and Amazon Web Services (AWS) terminology and services.
- Develop Hands-on experience with Virtualization and Container technologies
- Develop Hands-on experience with Automation technologies used by Cloud Enginee
- Gain practical skills in using automation technologies for cloud engineering.
- Learn to architect basic cloud solutions using industry-standard design patterns.

TEACHING METHODOLOGY

IE University teaching method is defined by its collaborative, active, and applied nature. Students actively participate in the whole process to build their knowledge and sharpen their skills. Professor's main role is to lead and guide students to achieve the learning objectives of the course. This is done by engaging in a diverse range of teaching techniques and different types of learning activities such as the following:

Learning Activity	**Weighting**	**Estimated time a student should dedicate to prepare for and participate in**

Lectures	20.0 %	15.0 hours
Discussions	6.7 %	5.0 hours
Exercises in class, Asynchronous sessions, Field Work	26.7 %	20.0 hours
Group work	26.7 %	20.0 hours
Individual studying	20.0 %	15.0 hours
TOTAL	100.0 %	75.0 hours

AI POLICY

Specific use cases of GenAI are encouraged

Generative artificial intelligence (GenAI) tools may be used in this course to aid Group Project design and development activities, with appropriate acknowledgement. GenAI may not be used for quizzes, exams or any in-class activities. If a student is found to have used AI-generated content inappropriately, it will be considered academic misconduct, and the student might fail the respective assignment or the course.

If you are in doubt as to whether you are using GenAI tools appropriately in this course, I encourage you to discuss your situation with me.

Below, a suggested format to acknowledge the use of generative AI tools. Please note that acknowledging AI will not impact your grade:

- *I acknowledge the use of [AI systems link] to [specify how you used generative AI]. The prompts used include [list of prompts]. The output of these prompts was used to [explain how you used the outputs in your work]*

If AI was permitted to use in your assignment, but you have chosen not to include any AI generated content, the following disclosure is recommended:

- *No content generated by AI technologies has been used in this assignment.*

PROGRAM

SESSION 1 (LIVE IN-PERSON)

Virtualization, Data Centers and Clouds

- Introduction to the Course
- Group Project Description: A Cloud Architecture Implementation
- Data Center Environment
- NIST Model of Cloud Computing
- Cloud Deployment Models (IaaS, PaaS, SaaS)
- Cloud Computing Service Models (Public, Private, Hybrid)

SESSION 2 (LIVE IN-PERSON)

Virtualization, Data Centers and Clouds

- Software-Defined Data Centers.
- Cloud/Flog/Edge Computing
- Virtualization Technology
- Virtual Box and Vagrant
- VMWare Products

- Container Technology
- Lab: Creating and Using Virtual Machines in the Cloud

SESSION 3 (LIVE IN-PERSON)

Docker Lab 1

- An introduction to Docker and how it works
- Image management
- Creating Docker images
- Managing containers
- Storing and managing data in volumes

SESSION 4 (LIVE IN-PERSON)

Docker Lab 2

- Linking your Docker containers
- Running a web server which is connected to a database
- Configuring containers using docker-compose

SESSION 5 (LIVE IN-PERSON)

Overview of Public Clouds (I)

Microsoft Azure Cloud Overview

- Azure basics
- Azure terminology
- Understand and Compare the most popular Azure services
- Hands-on demonstrations

AWS (Amazon Web Services) Cloud Overview

- AWS basics
- AWS terminology
- Understand and Compare the most popular AWS services
- Hands-on demonstrations

FinOps: managing and optimizing cloud spending

SESSION 6 (LIVE IN-PERSON)

Overview of Public Clouds (II)

Microsoft Azure Cloud Overview

- Azure basics
- Azure terminology
- Understand and Compare the most popular Azure services
- Hands-on demonstrations

AWS (Amazon Web Services) Cloud Overview

- AWS basics

- AWS terminology
- Understand and Compare the most popular AWS services
- Hands-on demonstrations

FinOps: managing and optimizing cloud spending

SESSION 7 (LIVE IN-PERSON)

Serverless Architectures

- Serverless Design Patterns
- Comparison with traditional server-based and container-based architectures
- Function as a Service (FaaS): Definition and use cases
- Backend as a Service (BaaS): Definition and common services
- Event-driven computing: Events, triggers, and event sources
- Simple Azure Functions hands-on example
- Simple AWS Lambdas hands-on example

SESSION 8 (LIVE IN-PERSON)

Knowledge Quiz 1

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IaaS Technology

- Refresher: Creating and Using Virtual Machines in the Cloud
- Linux concepts for Cloud Engineers
- Linux Architecture and Kernel
- Linux Filesystem Hierarchy Standard
- Basic Command Line usage

SESSION 9 (LIVE IN-PERSON)

IaaS Technology

- Cloud Engineering: Bash Shell Scripting Lab

SESSION 10 (LIVE IN-PERSON)

Infrastructure Automation: Ansible

- Understanding Ansible
- Setting up an environment for Ansible management
- Working with ad-hoc commands
- Understanding Ansible modules
- Automating configuration deployments using Ansible playbooks
- Using Variables and Facts
- Using Control Structures
- Templating with Jinja2

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Infrastructure Automation: Terraform

- Terraform overview and terminology. OpenTofu
- Terraform Workflow and Best Practices
- Hands-on exercise
- Advanced: Terraform and the Go programming language

SESSION 11 (LIVE IN-PERSON)

PaaS Technology

- Cloud Storage, Databases and Big Data Platforms.
- Azure Storage Accounts
- AWS S3 Buckets

SESSION 12 (LIVE IN-PERSON)

Other Cloud Design Patterns

- Load Balancing
- API Gateways
- Event-Driven and Stream Data Processing
- Cloud scalability: Kubernetes

Cloud Security and Operations

- Introduction to Cloud Security concepts and available tools.
- Azure Security Center & AWS Security Hub.
- Distributed Denial of Service (DDoS) attacks
- Critical Infrastructure Security and Resilience
- Zero Trust Security.
- The importance of Observability
- The role of the Site Reliability Engineer (SRE)
- Shared responsibility model in cloud security.

SESSION 13 (LIVE IN-PERSON)

Knowledge Quiz 2

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Emerging Trends and Future Directions in Cloud Computing

SESSIONS 14 - 15 (LIVE IN-PERSON)

Final Project Presentations

Each team will get 10-15 minutes to present their Cloud Architecture Implementation.

EVALUATION CRITERIA

Class Participation (20%)

Class participation includes in-class exercises and discussion board activities (details below), aimed at ensuring continuous learning, fostering teamwork, and applying class concepts to real-world problems.

Discussion Board Activity: Throughout the semester, the professor will share readings on the discussion board covering relevant topics. Students will be evaluated based on the timeliness and relevance of their contributions. Additionally, these readings will be included in in-class quizzes.

Individual Assignments (15%)

Multiple individual lab assignments will have to be completed for each of the course blocks.

Group Assignments (25%)

Group assignments to be completed in groups of 4-6 people.

Knowledge Quizzes (40%)

2 Knowledge Quizzes will test student's understanding of cloud concepts covered in lectures.

criteria	percentage	Learning Objectives	Comments
Class Participation	20 %		5% Discussion Forum, 15% other in-class activities
Individual Assignments	15 %		
Group Assignments	25 %		
Knowledge Quizzes	40 %		

RE-SIT / RE-TAKE POLICY

Each student has four chances to pass any given course distributed over two consecutive academic years: ordinary call exams and extraordinary call exams (re-sits) in June/July.

Students who do not comply with the 80% attendance rule during the semester will fail both calls for this Academic Year (ordinary and extraordinary) and have to re-take the course (i.e., re-enroll) in the next Academic Year.

Evaluation criteria:

Students failing the course in the ordinary call (during the semester) will have to re-sit the exam in June / July (except those not complying with the attendance rule, who will not have that opportunity and must directly re-enroll in the course on the next Academic Year).

The extraordinary call exams in June / July (re-sits) require your physical presence at the campus you are enrolled in (Segovia or Madrid). There is no possibility to change the date, location or format of any exam, under any circumstances. Dates and location of the June / July re-sit exams will be posted in advance. Please take this into consideration when planning your summer.

The June / July re-sit exam will consist of a comprehensive exam. Your final grade for the course will depend on the performance in this exam only; continuous evaluation over the semester will not be taken into consideration. Students will have to achieve the minimum passing grade of 5 and can obtain a maximum grade of 8.0 (out of 10.0) – i.e., “notable” in the in the re-sit exam.

Retakers: Students who failed the subject on a previous Academic Year and are now re-enrolled as re-takers in a course will be needed to check the syllabus of the assigned professor, as well as contact the professor individually, regarding the specific evaluation criteria for them as retakers in the course during that semester (ordinary call of that Academic Year). The maximum grade that may be obtained in the retake exam (3rd call) is 10.0.

After ordinary and extraordinary call exams are graded by the professor, you will have a possibility to attend a review session for that exam and course grade. Please be available to attend the session in order to clarify any concerns you might have regarding your exam. Your professor will inform you about the time and place of the review session. Any grade appeals require that the student attended the review session prior to appealing.

Students failing more than 18 ECTS credits in the academic year after the June-July re-sits will be asked to leave the Program. Please, make sure to prepare yourself well for the exams in order to pass your failed subjects.

In case you decide to skip the opportunity to re-sit for an exam during the June / July extraordinary call, you will need to enroll in that course again for the next Academic Year as a re-taker and pay the corresponding extra cost. As you know, students have a total of four allowed calls to pass a given subject or course, in order to remain in the program.

BIBLIOGRAPHY

Recommended

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- Thomas Erl, Eric Barceló Monroy. (2023). *Cloud Computing: Concepts, Technology, Security, and Architecture.* 2nd Edition. Pearson. ISBN 9780138052256 (Digital)
- Anders Lisdorf. (2021). *Cloud Computing Basics: A Non-Technical Introduction.* Apress. ISBN 9781484269213 (Digital)
- Paul Zikopoulos, Christopher Bienko, Chris Backer, Chris Konarski, Sai Vennam. (2021). *Cloud Without Compromise.* O'Reilly Media, Inc.. ISBN 9781098103736 (Digital)
- Divit Gupta. (2024). *The Cloud Computing Journey.* Packt Publishing. ISBN 9781805122289 (Digital)
- J.R. Storment, Mike Fuller. (2023). *Cloud FinOps.* 2nd Edition. O'Reilly Media, Inc.. ISBN 9781492098355 (Digital)
- Danil Zburivsky, Lynda Partner. (2021). *Designing Cloud Data Platforms.* Manning Publications. ISBN 9781617296444 (Digital)

- Mark Buckwell, Stefaan Van daele, Carsten Horst. (2024). *Security Architecture for Hybrid Cloud.* O'Reilly Media, Inc.. ISBN 9781098157777 (Digital)
- Kief Morris. (2020). *Infrastructure as Code.* 2nd Edition. ISBN 9781098114671 (Digital)
- Matthew A. Titmus. (2021). *Cloud Native Go.* O'Reilly Media, Inc.. ISBN 9781492076339 (Digital)
- Michael Hausenblas. (2022). *Learning Modern Linux.* O'Reilly Media, Inc.. ISBN 9781098108946 (Digital)
- Charity Majors, Liz Fong-Jones, George Miranda. (2022). *Observability Engineering.* O'Reilly Media, Inc.. ISBN 9781492076445 (Digital)

BEHAVIOR RULES

Please, check the University's Code of Conduct here. The Program Director may provide further indications.

ATTENDANCE POLICY

Please, check the University's Attendance Policy here. The Program Director may provide further indications.

ETHICAL POLICY

Please, check the University's Ethics Code here. The Program Director may provide further indications.