COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

GUÍA DOCENTE
2025 - 2026

FICHA TÉCNICA DE LA ASIGNATURA

Datos de la asignatura

Nombre completo	Optativa Complementaria. Procesamiento en Streaming
Código	DTC-MBD-525
Título	Máster en Big Data. Tecnología y Analítica Avanzada/Master in Big Data Technologies and Advanced Analytics
Créditos	3,0 ECTS
Carácter	Obligatoria
Departamento / Área	Departamento de Ciencias de la Computación e Inteligencia Artificial

Datos del profesorado

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DATOS ESPECÍFICOS DE LA ASIGNATURA

Contextualización de la asignatura

Aportación al perfil profesional de la titulación

By the end of the course, students will be able to:

- Understand the **core principles of stream processing**, including event-time processing, state management, fault tolerance, and scalability.
- Gain **practical experience with leading stream processing frameworks**, including:
  - Spark Streaming
  - Spark Structured Streaming
  - Kafka Streams
  - Apache Flink
- Acquire **basic working knowledge of the Scala language** applied to streaming use cases.

- Understand **cloud-native streaming architectures**, with a focus on AWS-managed services.
- Design, deploy, and operate **end-to-end streaming pipelines in the cloud**.
- Evaluate trade-offs between **on-premise vs. cloud-native streaming solutions**.
- Develop **well-formed criteria to select the most appropriate streaming technology** for a given use case, considering:
  - Latency requirements
  - Throughput and scalability
  - State management complexity
  - Operational overhead
  - Cost and cloud integration

Prerrequisitos

Students willing to take this course should be familiar with Scala and/or Java programming anguages. It will also be desirable to know the basic concepts of the streaming framework Kafka

Competencias - Objetivos

Competencias

General Competences

CG1. Advanced Knowledge and Methodology

Have acquired advanced knowledge and demonstrated, in a scientific, technological, or highly specialized context, a well-founded understanding of the theoretical and practical aspects, as well as the work methodologies, in one or more fields of study.

CG2. Knowledge Integration and Problem Solving

Be able to apply and integrate knowledge, scientific reasoning, and problem-solving skills in new or imprecisely defined environments, including multidisciplinary research and highly specialized professional contexts.

CG3. Critical Evaluation and Ethical Judgement

Be able to evaluate and select appropriate scientific theories and methodologies to formulate judgments based on incomplete or limited information, including, when relevant, reflection on the social and ethical responsibility associated with the proposed solutions.

CG4. Innovation and Management of Complex Systems

Be able to anticipate and manage the evolution of complex situations through the development of innovative methodologies adapted to scientific, technological, or professional environments, typically multidisciplinary in nature.

CG5. Scientific and Technical Communication

Be able to clearly and unambiguously communicate scientific and technological research results or state-of-the-art innovations to both specialist and non-specialist audiences, including the key foundations supporting them.

CG6. Autonomy and Research Collaboration

Have developed sufficient autonomy to participate in research projects and scientific or technological collaborations within their thematic area, in interdisciplinary contexts and, where applicable, with a strong knowledge-transfer component.

CG7. Professional Development and Lifelong Learning

Be able to take responsibility for their own professional development and ongoing specialization in one or more fields of study.

Specific Competences

CE4. Streaming Data Processing Technologies

Know and understand the techniques for processing streaming data, as well as the platforms, tools, and programming languages that enable real-time data processing.

Resultados de Aprendizaje

By the end of the course, students should be able to:

RA1. Demonstrate familiarity with the Scala language and functional programming principles.

RA2. Identify and describe the main characteristics and advantages of stream processing frameworks.

RA3. Design and develop code to process streaming data pipelines.

RA4. Demonstrate practical knowledge of Spark Structured Streaming and Kafka.

RA5. Understand, evaluate, and propose stream processing use cases, both in general and within industry contexts.

RA6. Use and understand common development tools and workflows applied in modern data engineering environments.

RA7. Plan and implement simple end-to-end streaming data projects.

BLOQUES TEMÁTICOS Y CONTENIDOS

Contenidos – Bloques Temáticos

Block 1 – Streaming and Kafka Fundamentals

1.1 Introduction to stream processing

1.2 Kafka fundamentals (core concepts, architecture, and use cases)

Block 2 – Essential Scala

2.1 Scala fundamentals

2.2 Development environment and tooling

2.3 Scala for data processing (practical approach

Block 3 – Spark Structured Streaming

3.1 Introduction to Spark Structured Streaming

3.2 Stateless and stateful operations

3.3 Time windows and watermarking

3.4 Output modes and output sinks

Block 4 – Kafka Streams

4.1 Introduction to Kafka Streams

4.2 Affinity, partitioning, and backpressure

4.3 Observability, tracing, and monitoring

Block 5 – Cloud Streaming (AWS)

5.1 Streaming architectures on AWS

5.2 AWS streaming services (Kinesis, MSK, etc.)

5.3 Demo: Streaming on AWS

5.4 Hands-on lab: Streaming on AWS

METODOLOGÍA DOCENTE

Aspectos metodológicos generales de la asignatura

In-Class Activities

Lectures

The lecturer will introduce the fundamental concepts of each unit, supported by practical recommendations and worked examples. Active student participation will be encouraged through open questions, guided discussions, quizzes, and short in-class application exercises.

These activities contribute to:

Understanding theoretical and practical foundations

Developing critical thinking and methodological reasoning

Fostering autonomy and lifelong learning skills

Practical Sessions

Under the instructor's supervision, students will apply the concepts introduced in lectures to real-world scenarios. These sessions focus on addressing and solving typical implementation and design problems encountered in streaming data processing.

These activities contribute to:

Applying and integrating knowledge in practical contexts

Problem-solving in complex and partially defined environments

Developing technical, collaborative, and communication skills

Tutoring

Tutoring sessions for groups or individual students will be organized upon request, providing personalized guidance and support throughout the course.

Out-of-Class Activities

Independent Study

Students are expected to study the course material independently and solve the proposed exercises to reinforce theoretical and practical knowledge.

Practical Session Preparation

Students will prepare practical sessions in advance in order to make efficient and effective use of in-class time.

Analysis and Reporting

Students will analyze the results obtained during practical activities and produce written reports, fostering structured reasoning, technical communication, and critical evaluation skills.

EVALUACIÓN Y CRITERIOS DE CALIFICACIÓN

Assessment Activity	Grading Criteria	Weight
Final Exam	• Understanding of theoretical concepts • Application of concepts to problem-solving • Critical analysis of numerical exercise results	40%
Practical Assignments	• Application of theoretical concepts to real-world problem-solving • Ability to interpret results in a real environment • Written communication skills	60%

Calificaciones

Regular Assessment

The **final exam** accounts for **40%** of the final grade.

Laboratory work (practical assignments) accounts for the remaining **60%**.

To pass the course under regular assessment, all of the following conditions must be met:

The **weighted average grade** must be **greater than or equal to 5.0 out of 10**.

The **final exam grade** must be **greater than or equal to 5.0 out of 10**.

The **laboratory grade** must be **greater than or equal to 5.0 out of 10**.

Failure to meet any of these conditions will result in the course being failed.

Retake Assessment

Students will always be required to take a **final exam**, which accounts for **40%** of the final grade.

Laboratory marks obtained during the regular assessment period will be preserved if they resulted in a passing grade.

If the laboratory component was not passed during regular assessment, the student must complete and submit a **final project**, which will replace the laboratory component.

The remaining **60%** of the final grade will be computed as follows:

Practical assignments (60%), if the laboratory was passed during regular assessment.

Final project (60%), if the laboratory was not passed.

As in the regular assessment period, to pass the course:

The **weighted average grade** must be **≥ 5.0 / 10**.

The **final exam grade** must be **≥ 5.0 / 10**.

The **laboratory or project grade** must be **≥ 5.0 / 10**.

If any of these conditions are not met, the **final course grade will be the lowest of the three marks**.

Course Rules

Attendance

Class attendance is mandatory in accordance with:

Article 93 of the *General Regulations* of Comillas Pontifical University.

Article 6 of the *Academic Rules* of the ICAI School of Engineering.

Non-compliance may result in the following consequences:

Students missing **more than 15% of lectures** may lose the right to take the final exam during the regular assessment period.

Missing **more than 15% of practical sessions** may result in losing the right to take the final exam in both the regular assessment and the retake.

Missed practical sessions must be made up in order to obtain credit.

Academic Integrity

Students who commit any irregularity in a graded activity will:

Receive a **grade of zero** for that activity.

Be subject to the corresponding **disciplinary procedures**, in accordance with Article 168 of the *General Regulations* of Comillas Pontifical University.

BIBLIOGRAFÍA Y RECURSOS

Bibliografía Básica

https://spark.apache.org/docs/2.4.0/structured-streaming-programming-guide.html

Bibliografía Complementaria

Programming Scala O'Reilly