National University of Engineering (UNI)
School of Computer Science
Syllabus 2027-I

1. COURSE

AI366. Distributed AI Systems (Elective)

2. GENERAL INFORMATION

2.1 Course	:	AI366. Distributed AI Systems
2.2 Cycle	:	CS300 Cycle.
2.3 Credits	:	4
2.4 Hours	:	2 HT; 4 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	• AI264. Deep Learning. (7^{th} Sem) • AI265. Reinforcement Learning.

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course covers the design and implementation of distributed AI systems, including federated learning, swarm intelligence, and decentralized architectures for collaborative model training.

5. GOALS

- Implement federated learning algorithms
- Design decentralized training architectures
- Evaluate privacy-communication-efficiency tradeoffs

6. COMPETENCES

AG-C05) Project Management: Applies management principles in computing to manage projects. (Usage)

AG-C09) Design and Development of Solutions: Designs, implements, and evaluates solutions for complex computing problems. (Usage)

7. TOPICS

Unit 1: Distributed AI Fundamentals (12 hours)	
Competences Expected: AG-C05,AG-C09	
Topics	**Learning Outcomes**
• Centralized vs decentralized architectures • Communication protocols (gRPC, MPI) • Synchronization in heterogeneous systems	• Compare distribution approaches [Evaluar] • Configure distributed testbeds [Usar]
Readings : [BKM19]	

Unit 2: Advanced Techniques (24 hours)	
Competences Expected: AG-C05,AG-C09	
Topics	**Learning Outcomes**
• Federated learning (horizontal/vertical) • Swarm optimization algorithms • Blockchain for decentralized AI	• Implement FL with PySyft [Usar] • Design fault-tolerant systems [Evaluar]
Readings : [NNK22], [LLZ21]	

Unit 3: Security & Governance (8 hours)	
Competences Expected: AG-C05,AG-C09	
Topics	**Learning Outcomes**
• Distributed system attacks (poisoning, sybil) • Model consensus mechanisms • Governance in collective autonomous systems	• Analyze attack vectors [Familiarizarse] • Implement basic defenses [Usar]
Readings : [BKM19]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

Theory Sessions:
The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

Lab Sessions:
In order to verify their competences, several activities including active learning and roleplay will be developed during lab sessions.

Oral Presentations:
Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

Reading:
Throughout the course different readings are provided, which are evaluated. The average of the notes in the readings is considered as the mark of a qualified practice. The use of our virtual campus allows each student to access the course information, and interact outside the classroom with the teacher and with the other students.

The final grade NF depends on the following grades:

- PE: Partial Exam.
- FE: Final Exam.
- P: Permanent Evaluation (Average of practical work and graded assignments).

The final grade NF is calculated as follows:

$$NF = \frac{PE + FE + P}{3}$$

10. BASIC BIBLIOGRAPHY

[BKM19] Keith Bonawitz, Peter Kairouz, and Brendan McMahan. *Federated Learning: Fundamentals and Advances*. MIT Press, 2019.

[LLZ21] Qiang Li, Yibo Lin, and Zhengyuan Zhou. "Decentralized Federated Learning: A Survey and Perspective". In: *NeurIPS*. 2021.

[NNK22] Thi Nguyen, Dinh Nguyen, and Nguyen Lu Dang Khoa. "Swarm Intelligence for Distributed Machine Learning". In: *IEEE Transactions on Neural Networks* 33.7 (2022).