

## COMP 356E Database Systems Technology

**Professor:** Rafael Pachón Alvarez

**Office:** CUI

**Email:**

**Office Hours:** By appointment (please allow at least 48 hours for your instructor to respond to your emails)

**Course information:**

Spring 2024

### Course Description

This course is an introduction to database systems. We will explain how to query database systems via languages such as SQL. Then, we will see how database systems work internally, how they store and index data, how they process and optimize queries, and how they process transactions while providing guarantees such as isolation, atomicity, and durability (ACID guarantees).

Different database systems such as distributed DBMS, In-Memory databases and NoSQL databases will also be introduced.

### Course Goals

It is expected that students get to know how a database works under different situations and with different technologies. This knowledge should help students to understand and solve different practical problems that can happen in their future professional career.

In addition, students will be introduced to different database types to provide them with an overview about benefits and drawbacks of each one.

Finally, we will explain how data can be uploaded to and fetched from a database so it can be added to a regular calculation procedure in a programming language.

### Methodology

This course consists of 26 face-to-face sessions where both theoretical knowledge and practical sessions will be taught.

Students will be given both comprehensive documentation and slides for each session. It is recommended that students look at the documentation in advance.

Class attendance and participation will be mandatory as, at the end of each unit, practical exercises will be proposed. Presentations or discussions among students will be requested so everyone can learn from other's experience and conclusions.

## Technical Requirements

This course will require students to bring their laptop for the classes that require running databases examples. (Databases will not be running on tablets or smartphones).

## Course Materials

Textbooks are not required for this course as course materials will be provided in advance.

### Complementary Bibliography

1. Fundamentals of database systems. Ramez Elmasri, Shamkant B. Navathe. Pearson
2. Database Systems. Thomas Connolly, Carolyn Begg. Pearson

**Note:** It is not expected students bought any of these books. Topics in this subject are build from them but none of them are completely covering the subject. Students will be given the information already prepared by the teacher for them to study. Besides this, these books will be available at CUID's library for reference (not at UPO's library).

## Course Requirements and Grading

Your final grade will be calculated as follows:

- Class participation: 20%
- Practical exercises and in-class presentations: 40%
- Mid-term exam: 20%
- Final exam: 20%

During the course, students will be given some questions or practical exercises to be solved in groups and then presented and commented in class in a "learning by doing" approach. If a student is confident enough to provide other students with an explanation, this will mean the knowledge is mastered. Therefore, it is highly recommended for students to attend not only lectures but also presentations and discussions.

It is mandatory to pass the exams to pass the subject.

Exams and every other assignment will be marked following the Spanish numerical range. Here is a table to illustrate differences in conversion between the Spanish, U.S. and Standard European grading systems:

SPAIN	10	9,9	9,4	8,9	8,4	7,9	7,4	6,9	6,4	5,9	5,4	4,9
		-	-	-	-	-	-	-	-	-	-	-
		9,5	9	8,5	8	7,5	7	6,5	6	5,5	5	0
USA	A+	A	A-	B+	B	B	B-	C+	C	C	C-	F
ECTS	A	B	B	C	C	C	C	D	D	E	E	F

## General Course Policies

Each student is expected to be familiar with the course syllabus. Students are expected to focus their full attention on the class, arrive on time, and stay until class ends. Leaving the classroom on repeated occasions is disturbing to both your professor and your classmates and may adversely affect your participation grade. Please make use of the 10-minute breaks in between classes to fill up your water bottle, use the restroom, etc.

Students are expected to listen and respect other points of view. Phone calls, social media, email, or Internet browsing at any time during class are not acceptable except for specific class-related activities expressly approved by your instructor. You are responsible for any course material covered in class, announcements, and/or handouts if you are not present for any reason. Students will be held responsible to be up to date by attending class regularly and checking both email and the Blackboard site of the course frequently (monitor your email and Blackboard announcements at least once every 24 hours).

Communicating with the instructor: Please allow at least 48 hours for your instructor to respond to your emails. The weekend is not included in this timeframe. If you have an urgent request or question for your professor, be sure to send it during the week.

## Attendance and Punctuality

Attendance is mandatory in all classes. As we understand that you might fall ill or be unable to come to class (e.g. due to a religious holiday, a flight delay, a family wedding/reunion, a graduation, a job interview, etc.) at some point during the semester, you are allowed up to 4 absences. You will be responsible for the material covered and any work missed. You will not need to justify your absences (up to 4) in any way unless you miss an exam, a presentation, a quiz, etc. In this case, you must present a doctor's note (signed, stamped and dated) to be able to reschedule the exam, etc. It will still count as an absence but you will be allowed to retake the exam, etc. We don't encourage you to use all 4 days unless you really need them as your participation grade may suffer if you are not in class. If used unwisely and you get sick late in the semester, the following penalties will apply:

- On your 5th absence, 1 point will be taken off of your final Spanish grade
- On your 6th absence, 3 points will be taken off of your final Spanish grade
- On your 7th absence, you will automatically fail the class

## Office hours

If students seek help from the professor, they can meet him during office hours (11:50 – 12.50).

## COVID-19

If an absence is related to COVID-19 the procedure to follow will be in accordance with the current legislation in the region of Andalucía, Spain.

## Academic Honesty

Academic integrity is a guiding principle for all academic activity at Pablo de Olavide University. Cheating on exams and plagiarism (which includes copying from the Internet) are clear violations of academic honesty. A student is guilty of plagiarism when they present another person's intellectual property as their own. The penalty for plagiarism and cheating is a failing

grade for the assignment/exam and a failing grade for the course. The International Center may also report this to your home university. Avoid plagiarism by citing sources properly, using footnotes and a bibliography, and not cutting and pasting information from various websites when writing assignments.

### **Learning Accommodations**

If you require special accommodations or have any other medical condition you deem may affect your class performance, you must stop by the International Center to speak to Marta Carrillo (mcaroro@acu.upo.es) to either turn in your documentation or to confirm that our office has received it. Marta will explain the options available to you.

### **Behavior Policy**

Students are expected to show integrity and act in a professional and respectful manner at all times. A student's attitude in class may influence his/her participation grade. The professor has a right to ask a student to leave the classroom if the student is unruly or appears intoxicated. If a student is asked to leave the classroom, that day will count as an absence regardless of how long the student has been in class.

### **Course Contents**

#### **Unit 1. Introduction to databases**

- Introduction
- History of Database Applications
- Databases vs File system
- Characteristic of the database approach
- Summary

#### **Unit 2. SQL review**

- Entity-Relation model
- Data Definition Language (DDL)
- Data Manipulation Language (DML)
- Cardinality restrictions
- Summary
- Examples

#### **Unit 3. Transaction Management**

- Introduction
- ACID concept
- Properties
- Concurrency of users
- Sequentially and interference
- Isolation level
- Failure recovery
- Roles on DBMS

- Summary and review questions

#### **Unit 4. Query Processing**

- Translating SQL into linear algebra
- Algorithms for external sorting
- Algorithms for SELECT and JOIN operations
- Implementing Aggregate Operations and OUTER JOINS
- Pipelining
- Summary and review questions

#### **Unit 5. Index structures**

- Disk storage, basic file structure and hashing
- Single-Level ordered Indexes
- Multilevel indexes
- Dynamic multilevel Indexes using B/B\*-Trees and B+-Trees
- Summary and review questions

#### **Unit 6. Query Optimization**

- Heuristic query optimization
- Selectivity and Cost Estimates in query optimization
- Semantic query optimization
- Summary and Review questions

#### **Unit 7. Distributed DBMS**

- Differences between distributed database systems, distributed processing, and parallel database systems
- Advantages and disadvantages of distributed DBMS
- Problems of heterogeneity
- Basic networking concepts
- Summary

#### **Unit 8. In-Memory databases**

- Description
- Advantages and disadvantages
- ACID support
- Hybrids with on-disk databases
- Summary
- SQL Lite exercises

#### **Unit 9. Alternative database models**

- NoSQL vs SQL
- Architecture
- Advantages and disadvantages
- noSQL systems
- Document oriented database: MongoDB
- Columnar Database: MariaDB
- Graph oriented database: Neo4j
- Exercises

### **Unit 10. Connection to programming languages**

- JPA
- ADO
- SQLAlchemy
- Exercises



## Calendar

Regarding proposed calendar, students must keep in mind dates corresponding to evaluated activities such as exams or practices.

January						
L	M	X	J	V	S	D
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25 Pres	26	27	28
29	30 Unit 01	31				

February						
L	M	X	J	V	S	D
			1 Unit 02	2	3	4
5	6 Unit 02	7	8 Unit 03	9	10	11
12	13 Unit 03	14	15 Unit 03	16	17	18
19	20 Unit 04	21	22 Unit 04	23	24	25
26	27 Unit 04	28	29			

March						
L	M	X	J	V	S	D
				1	2	3
4	5 Pract 1	6	7 Unit 05	8	9	10
11	12 Unit 05	13	14 Unit 05	15	16	17
18	19 Pract 2	20	21 Exam	22	23	24
25	26	27	28	29	30	31

April						
L	M	X	J	V	S	D
1	2 Unit 06	3	4 Unit 06	5	6	7
8	9 Pract 3	10	11 Unit 07	12	13	14
15	16	17	18	19	20	21
22	23 Unit 07	24	25 Unit 08	26	27	28
29	30 Unit 09					

May						
L	M	X	J	V	S	D
		1	2 Unit 09	3	4	5
6	7 Unit 10	8	9 Unit 10	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Practical session
Exam
Presentation
No Classes