

| Degree programme     | Type | Course |
|----------------------|------|--------|
| Computer Engineering | OB   | 3      |
| Computer Engineering | OP   | 4      |

### Contact lecturer

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### Prerequisites

It is recommended that the student has knowledge and skills corresponding to the contents of the subject of databases. In addition, it is recommended that students have achieved programming skills in Python, bash scripting and are familiar with working in Linux OS.

### Group languages

You can consult this information at the [end](#) of the document.

### Objectives

In this course we introduce the advanced concepts of Databases (DB) necessary both at the designer level of BD and user.

#### KNOWLEDGE:

- To know, to understand and to know how to use the main DB management tools to be able to parameterize the BD in the most optimum way according to the needs of users and processes.
- To know, to understand and to know how to use the main DB optimization tools.
- To understand and to know how to configure distributed DBs.
- To understand and to know how to use non-relational DB.

#### SKILLS:

- To set up a DB system in the most optimal way based on some needs.
- To optimize the execution of transactions that maximizes the response time and the use of resources available to the DB.
- To use the SQL language immersed to design, program and verify DB applications based on programming languages and SQL.
- To use and configure a non-relational DB based on a DB design I/O.

To work with the previous skills with relational DBMS, such as ORACLE, which is widely used in the professional field, both at user level and administrator level and non-relational DBMS, such as MongoDB.

### Learning outcomes

1. Develop a capacity for analysis, synthesis and prospection.
2. Know the methods for optimising databases and the mechanisms of administration and parametrisation

- of the same.
3. Develop and maintain data models that serve as a basis for software systems.
  4. Apply different management tasks of DB in practice cases.
  5. Know the limitations of different error recovery systems and understand the process involved in Rollback.
  6. Apply query scheduling for resource optimization.
  7. Know the mechanisms of consultation and synchronization of nodes in distributed systems.
  8. Know the bases of the paradigm of DDBB oriented to objects.

## Contents

### 1. Access and security control (5 hours)

- Discretionary access control (DAC).
- Mandatory access control (MAC).
- Role-based access control (RBAC).

### 2. Internal level in Oracle and PL/SQL (10 hours)

- Internal representation of data: tablespaces and datafiles.
- Concepts and system logs.
- System logs in Oracle: ARCHIVELOG and NOARCHIVELOG
- PL/SQL: basic structures, procedures, functions and triggers.

### 3. DB Recovery (10 hours)

- Recovery concepts.
- Recovery techniques based on delayed and immediate update.
- Shadow paging.
- ARIES Algorithm.
- Database backup and recovery against catastrophic failures.

### 4. Transaction management and process (5 hours)

- ACID properties.
- Transaction planning.
- Classification of transactions based on serialization.

### 5. Concurrency control protocols (25 hours)

- Administration of SQL transactions.
- Deadlock and starvation
- Locking techniques: Granularity
- Techniques based on temporary brands
- Multiverse techniques

### 6. Queries optimization (25 hours)

- Indexation and hashing
- Architecture.
- Translation of SQL queries
- Implementation of relational operators
- Process in sequence
- Heuristics of optimization

### 7. No relational DBs: MongoDB (10 hours)

- Introduction to no relational databases
- Introduction to MongoDB: collections and documents

- Basic concepts of MongoDB queries
- Security in MongoDB: users and roles
- Internal level in MongoDB: WiredTiger
- Execution plan in MongoDB.

#### 8. Distributed BD (30 hours)

- Basics
- Techniques of fragmentation, replication and allocation of data
- Types of distributed BD systems
- Concurrence control
- DDB in Oracle and MongoDB

\* The hours in parentheses are estimates of the hours that the students will dedicate to each subject, counting the classroom hours in class and the hours outside the classroom.

### Learning activities and methodology

| Title                                  | Hours | ECTS | Learning outcomes      |
|----------------------------------------|-------|------|------------------------|
| Problem solving and practicum          | 24    | 0.96 | 1, 2, 4, 6             |
| Practicum                              | 39    | 1.56 | 1, 2, 3, 4, 6          |
| Study and preparation of partial tests | 20    | 0.8  | 1, 2, 5, 7, 8          |
| Inclass sessions                       | 26    | 1.04 | 1, 2                   |
| Previous work                          | 26    | 1.04 | 1, 2, 3, 4, 5, 6, 7, 8 |

In this course we will follow a flipped classroom methodology. In this methodology, the study of the theoretical contents must be carried out before the face-to-face sessions, as an autonomous activity of the students, and from material and documentation that students will have access through the virtual campus of the course. The face-to-face classes become practical sessions of problem solving and practices, aimed at solving all the doubts and problems that may have been encountered throughout the week.

Two types of activities will be carried out: problem solving and practices. Problem solving is aimed at consolidating the most theoretical aspects of the course. A part of them will be individual while others will be carried out in groups. The practices will be essentially practical group activities that will be carried out throughout the course.

The working groups will be groups of 3 students, will be formed on the first day of class and will remain stable throughout the course. They will be the same for the group theory activities and the project. Not counting the hours that have to be dedicated to preparing the partial exams and the hours in the face-to-face classes. An average load of 6 autonomous works hours per week and student has been calculated distributed in the following activities:

- Previous work: it is estimated an average of 2 hours per week that must be dedicated to reading or visualizing the material that will be worked on in the face-to-face sessions.
- Realization of the practices: it is estimated an average of 2 to 3 hours per week and student who must dedicate himself to doing the practices in addition to the hours that are dedicated punctually to the sessions dedicated to the resolution of problems.
- Problem solving: the weeks with less workload dedicated to the practices will be dedicated from 1 to 2 hours to make more resolutions of exercises and problems of the topics worked on in the face-to-face sessions.

Annotation: within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

## Assessment

### Continuous assessment activities

| Title                             | Weight | Hours | ECTS | Learning outcomes      |
|-----------------------------------|--------|-------|------|------------------------|
| 1st Theory exam                   | 0.25   | 2     | 0.08 | 1, 3, 5                |
| Problem delivery (NPrb)           | 0.1    | 2     | 0.08 | 1, 2, 3, 4, 5, 6, 7, 8 |
| Practicum deliveries              | 0.5    | 6     | 0.24 | 1, 2, 3, 4, 6          |
| 2nd Theory exam                   | 0.25   | 2     | 0.08 | 1, 2, 6, 8             |
| peer correction exercises (CorPr) | 0.05   | 3     | 0.12 | 1, 4, 6, 8             |

The evaluation will be carried out continuously. There will be two individual theoretical-practical tests in writing, with a weight of 50% each on the final grade. The first test (Par1) will be done approximately in the middle of the semester and will evaluate the theoretical concepts and management and administration skills of databases treated in the 1st part of the course. The second test (Par2) will be carried out at the end of the semester and will evaluate the theoretical concepts and management and administration skills of databases treated in the 2nd part of the course.

Most weeks there will be the possibility of submitting activities done during the week. The submission is optional and can be made up to hours set in advance at the Virtual Campus. With 80% of the highest possible grade you can achieve the highest grade (1 point) of this activity (NPrb). The grade will be obtained from cross-correction activities between students that are enabled for each submission.

Cross-correction problems (CorPr) are also optional and can be done by students who have delivered the exercises. Students can obtain a maximum of one point from this activity that will be added to the Theory grade provided that a grade  $\geq 3.5$  has been achieved in the average of the 2 partials. The Theory Grade may under no circumstances exceed 10.

The grade of practices will be the result of averaging the grades obtained in each practice delivery. There will be 3 deliveries: Prac1, Prac2 and Prac3. The maximum grade of the second chance practice submission will be 5.

Practice grades will be calculated as the average of the grades for the three practical assignments: Prac1, Prac2, and Prac3. During the practical sessions, the instructor will assess each student's level of participation. The participation grade will be an individual participation factor, within the range of 0, 1, or 2, applied to the exercises completed during the session. If a student does not attend a session or does not demonstrate sufficient understanding of the exercises, the participation grade for that session will be 0. The grades obtained in the practical assignments cannot be retaken or recovered.

To be eligible for the calculation of the FINAL COURSE GRADE, students must obtain a grade greater than 0 in all midterm exams and in all practical assignments. Otherwise, the student will be required to take the resit examination described below.

Retake exam: In the event that the FINAL GRADE SUBJECT does not reach the approved grade, students may take a retake exam on all the contents covered in the subject, both in the theory and problem sessions and in the practicals. The final grade of the subject will be a maximum of 5.

#### QUALIFICATION INDICATORS:

The final grade of the subject is calculated as follows:

- Nota Parcial 1 = Par1
- Nota Parcial 2 = Par2
- Nota Teoria =  $0'5 \cdot \text{Par1} + 0'5 \cdot \text{Par2} + \text{NPrb} + \text{CorPr}$
- Nota Pràctiques =  $\frac{1}{3} \cdot \text{Prac1} + \frac{1}{3} \cdot \text{Prac2} + \frac{1}{3} \cdot \text{Prac3}$
- FINAL GRADE SUBJECT =  $0'5 \cdot \text{Nota Teoria} + 0'5 \cdot \text{Nota Pràctiques}$

#### EVALUATION CRITERIA

- To account for the notes of problems (NPrb) and cross-corrections (CorPr) you must obtain a minimum of 3.5 in the average of the partials:  $= 0'5 \cdot \text{Par1} + 0'5 \cdot \text{Par2} > = 3.5$ .
- The course will be passed if the FINAL GRADE SUBJECT is greater than or equal to 5. In the case of not reaching the minimum required in any of the evaluation activities, the numerical grade will be the lowest value between 4.5 and the weighted average of the grades.
- NOT EVALUABLE: If you do not present any evaluation activity.
- REPEATERS: No passed part (theory, practices) is kept from one academic year to another.
- This subject does not include the single evaluation system.
- IMPORTANT FOR ALL STUDENTS: It is important to register in the virtual campus of the course in the Virtual Campus (<http://cv.uab.cat>), because the materials, the activities and the final grades of the course are published there.
- Granting an honors grade is the decision of the faculty responsible for the course. The UAB regulations indicate that the MH can only be granted to students who have obtained a final grade equal to or greater than 9.00. Up to 5% MH of the total number of students enrolled can be awarded.

#### EVALUATION CALENDAR:

- Partial Exams: schedule announced at the beginning of the semester.
- Retake Exam: according to the academic calendar of the Engineering School.
- Activities submissions: date and time fixed in advance to the Virtual Campus.
- Practice submissions: date and time fixed in advance to the Virtual Campus.
- In the event of a serious illness or any other duly justified exceptional circumstance that prevents the student from completing an assessment activity, a request for rescheduling may be submitted through the Academic Administration Office.

The delivery dates will be published in the Virtual Campus (<http://cv.uab.cat>) and may change due to be adapted to any unexpected incidents. Any change will also be announced through Virtual Campus since it is the usual communication channel between teachers and students.

For each assessment activity, a place, date and time of revision will be indicated in which the student will be able to review the activity with the teacher. In this context, claims can be made about the activity score, which will be evaluated by the teachers responsible for the subject. If the student does not submit to this review, this activity will not be reviewed later.

The use of Artificial Intelligence (AI) technologies is allowed, except in those activities that are otherwise specified, as an integral part of the development of the work, provided that the final result reflects a significant contribution of the student in the analysis and personal reflection. The student should clearly identify which parts have been generated with this technology, specify the tools used, and include critical reflection on how

these have influenced the process and the final outcome of the activity. The non-transparency of the use of AI will be considered academic dishonesty and may lead to a penalty in the grade of the activity, or greater sanctions in cases of severity.

Without prejudice to other disciplinary measures deemed appropriate, and in accordance with the current academic regulations, irregularities committed by a student who may lead to a variation of the qualification in an assessable activity will be graded with zero (0). Assessment activities qualified in this way and by this procedure will not be recoverable. If it is necessary to pass any of these assessment activities to pass the subject, this subject will be suspended directly, without opportunity to recover it in the same course. These irregularities include, among others:

- the total or partial copy of a lab exercise, report, or any other evaluation activity;
- let another student to copy;
- unauthorized use of AI (e.g., Copilot, ChatGPT or equivalent);
- present a group work not done entirely by the members of the group (applied to all members and not only to those who have not worked);
- present as own materials prepared by a third party, even if they are translations or adaptations, and generally works with non-original and exclusive elements of the student;
- have communication devices (such as mobile phones, smart watches, pens with camera, etc.) accessible during theoretical-practical assessment tests (individual exams);
- talk with classmates during the individual theoretical-practice tests (exams);
- copy or attempt to copy from other students during the theoretical-practical assessment tests (exams);
- use or attempt to use written material related to the subject during the theoretical-practical evaluation tests (exams), when these have not been explicitly allowed.

The numerical official grade will be the lowest value between 3.5 and the average weighted grades in case the student has committed irregularities in an evaluation act (and therefore the subject cannot be passed by compensation). In future editions of this subject, the student who has committed irregularities in an evaluation act will not be validated any of the assessment activities carried out.

In summary: copy, let copy or plagiarize (or attempt) in any of the assessment activities will lead to a FAIL, not compensable and without validations of parts of the subject in subsequent courses.

## Bibliography

COURS MATERIAL: <http://cv.uab.cat>.

### BASIC BIBLIOGRAPHY:

- A. Silberschatz, H.F. Korth, S. Sudarshan. *Database System Concepts*, 7th Edition, McGraw-Hill, 2020.
- R. Elmasri, S.B. Navathe. *Fundamentals of Database Systems*, 7th Edition, Pearson, 2021.
- T. Connolly, C. Begg. *Database Systems: A Practical Approach to Design, Implementation and Management*, 7th Edition, Pearson, 2026.

### COMPLEMENTARY BIBLIOGRAPHY:

- M. Kleppmann. *Designing Data-Intensive Applications*, O'Reilly, 2017.
- A. Petrov. *Database Internals*, O'Reilly, 2019.
- Ramakrishnan, Gehrke. *Database Management Systems*, 3rd Edition, McGraw-Hill, 2003.
- C.J. Date. *An Introduction to Database Systems*.

### WEB RESOURCES

- <https://www.postgresql.org/docs/>
- <https://www.mongodb.com/docs/>
- <https://docs.oracle.com/en/database/>
- <https://learn.microsoft.com/sql/>
- <https://sigmod.org/>
- <https://db-engines.com/en/ranking>

## Software

To do the project the following software is needed

- Python IDE: Pycharm
- Ssh client
- Control version systems (CVS) like github, bitbucket or similars

## Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this [link](#). To access the information, you will need to enter the course CODE

| Type of teaching              | Group | Language | Semester       | Shift         |
|-------------------------------|-------|----------|----------------|---------------|
| (TE) Theory                   | 420   | Spanish  | first semester | morning-mixed |
| (PAUL) Classroom practices    | 421   | Spanish  | first semester | morning-mixed |
| (PLAB) Practical laboratories | 421   | Catalan  | first semester | morning-mixed |
| (PAUL) Classroom practices    | 422   | Spanish  | first semester | morning-mixed |
| (PLAB) Practical laboratories | 422   | Catalan  | first semester | morning-mixed |
| (PLAB) Practical laboratories | 423   | Spanish  | first semester | morning-mixed |
| (PLAB) Practical laboratories | 424   | Spanish  | first semester | morning-mixed |