Databases

Module Description

Module code	CS302-F28	**Credits**	7 ECTS
Programme	Foundation programme	**Level**	Semester 5
Semester	Fall 2028	**Prerequisites**	MAT101-F26 Discrete Structures; CS103-S27 Data Structures and Algorithms I
Module leader	Dr. Ali Khudiyev	**Email**	ali.khudiyev@wosm.academy
Office hours	Monday–Friday, 10:00–17:00 (Baku time, UTC+4)		

1. Module Overview

Almost every application stores data that must outlive the program, be shared by many users and stay consistent when things go wrong. This module teaches how to design, query and build such databases, with the emphasis on relational databases and SQL.

The first part is about *using* databases: the relational model, relational algebra, SQL, conceptual design with entity–relationship models, and normalisation. The second part is about how a database system *works inside*: storage, indexing, query processing and optimisation, transactions, concurrency control and recovery. It draws on the data structures from Data Structures and Algorithms I and the systems ideas from Operating Systems. The module ends with a look at distributed and non-relational data stores.

2. Aims

- Teach the relational model and SQL as the standard way to describe and query data.
- Develop your ability to design sound database schemas.
- Explain how a database system stores, indexes and queries data efficiently.
- Explain how transactions keep data consistent under concurrency and failures.

3. Learning Outcomes

After completing this course, you will be able to:

LO1. Design database schemas with entity–relationship modelling and translate them into relational schemas with keys and integrity constraints.

LO2. Express queries in relational algebra and SQL, including joins, aggregation, subqueries and views.

LO3. Use functional dependencies to evaluate schemas and normalise them into 3NF and BCNF.

LO4. Explain storage and index structures such as B+ trees and hash indexes, and how queries are evaluated and optimised.

LO5. Explain transactions, the ACID properties, serialisability, locking-based concurrency control and log-based recovery.

LO6. Build an application in Java that uses a relational database through JDBC.

4. Syllabus

Unit	Topic
1	Introduction: data, databases and database management systems
2	The relational model; keys and integrity constraints
3	Relational algebra
4	SQL I: data definition and basic queries
5	SQL II: joins, aggregation, subqueries and NULL values
6	SQL III: views, constraints and triggers; databases from Java with JDBC
7	Conceptual design: entity–relationship modelling
8	From entity–relationship diagrams to relational schemas
9	Functional dependencies and normal forms: 3NF and BCNF
10	Storage: disks, pages, files and records
11	Indexing: B+ trees and hash indexes
12	Query processing: sorting and join algorithms
13	Query optimisation
14	Transactions and concurrency control: serialisability, two-phase locking
15	Recovery: logging and the write-ahead log
16	Beyond relational databases: distributed and NoSQL data stores
17	Course Review & Exam

5. Teaching and Learning Methods

The module is self-paced. All materials are provided on Moodle. Each unit has a lecture and exercises. Practical work uses a relational database system to write SQL queries and to build a small database-backed Java application.

Activity	Hours
Lectures	34
Labs / Tutorials	36
Independent study	130
Total	**200**

6. Assessment

Your knowledge will be assessed throughout the course with quizzes, a database project and the final exam. The project checks whether you can design a schema, query it in SQL and use it from an application. The exam also covers how database systems work internally.

Component	Weight	Due	LOs
Quizzes	20%	Throughout	LO1–LO5
Database project	40%	Throughout	LO1, LO2, LO3, LO6
Final exam	40%	End of module	LO1–LO5
Total	**100%**		

7. Reading List

Essential

- A. Silberschatz, H. F. Korth, S. Sudarshan: *Database System Concepts*, 7th ed., McGraw-Hill, 2019.

Recommended

- H. Garcia-Molina, J. D. Ullman, J. Widom: *Database Systems: The Complete Book*, 2nd ed., Pearson, 2008.
- R. Ramakrishnan, J. Gehrke: *Database Management Systems*, 3rd ed., McGraw-Hill, 2003.
- M. Kleppmann: *Designing Data-Intensive Applications*, O'Reilly, 2017.

8. Materials and Licence

Course materials are published under the Creative Commons Attribution-ShareAlike 4.0 licence unless stated otherwise. See wosm.academy/licence for details.

9. Policies

- **Attendance:** Attendance is not mandatory. The module is self-paced, so you can study the materials when it suits you.
- **Late submissions:** Work submitted after the deadline is penalised.
- **Academic integrity:** All submitted work must be your own. See the Code of Conduct.