



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

Management of SQL and NoSQL databases [S1Inf1>SQL]

### Course

Field of study

Computing

Year/Semester

3/5

Area of study (specialization)

–

Profile of study

general academic

Level of study

first-cycle

Course offered in

Polish

Form of study

full-time

Requirements

compulsory

### Number of hours

Lecture

30

Laboratory classes

24

Other

0

Tutorials

0

Projects/seminars

0

### Number of credit points

5,00

### Coordinators

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### Lecturers

### Prerequisites

A student beginning this course should have a basic knowledge of programming fundamentals, computer system architecture, operating systems, and database systems. A student should have the ability to obtain information from the indicated sources. A student should also understand the need to expand his competencies and have a willingness to cooperate as part of a team. In addition, in terms of social competence, the student must present such attitudes as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

### Course objective

1. To provide students with the basic knowledge of database systems technology necessary for the proper design, use and implementation of database systems and their applications. 2. To develop students' ability to solve problems that arise in the management of database systems.

### Course-related learning outcomes

Knowledge:

- student has a structured, theoretically based general knowledge of conventional databases and NoSQL databases (K1st\_W4),

- student has detailed knowledge about the management of database systems, including transactionality, mechanism of database disaster recovery (K1st\_W5),
- student has basic knowledge about the life cycle of SQL and NoSQL database systems (K1st\_W6),
- student knows basic methods, techniques and tools used in solving simple computer tasks in the field of database management, (K1st\_W7).

#### Skills:

- student is able to acquire knowledge from various sources, including literature and databases, as well as interpret it properly, draw conclusions and justify opinions (K1st\_U1),
- student is able, solving the problem of data processing in databases, to apply appropriate methods and algorithms (K1st\_U4),
- student is able to make a critical analysis of the functioning of the database system and prepare functional and efficiency tests of the operation of the information system using the database system (K1st\_U9),
- student is able, according to a given specification, to develop and implement a model of a fragment of reality, formulate a functional specification of an information system and implement an information system using a database system with the use of one of the popular DBMS (K1st\_U10),
- student is able to formulate data processing algorithms and implement them using at least one of the popular tools (K1st\_U11),
- student is able to plan and carry out the process of self-education and knows the possibilities of further education (K1st\_U19).

#### Social competences:

- student understands that in computer science, within the framework of database issues, knowledge and skills become obsolete very quickly (K1st\_K1),
- student is aware of the importance of database knowledge in solving engineering problems, and knows examples and understands the causes of malfunctioning information systems (K1st\_K2),
- student is able to think and act in an entrepreneurial manner (K1st\_K3).

### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The basis for assessment in this course is the result obtained in a written examination consisting of a set of open-ended tasks. Each task is scored on a scale of 0 to 10 points. A total score greater than or equal to 50% of the maximum score guarantees a pass.

Additionally, the final grade for the course may be increased based on the student's activity during lectures. At each lecture, students solve tasks illustrating the problems presented in the lecture. In this way, the grade can be increased by half or a whole grade.

The verification of the intended learning outcomes in the laboratory is carried out by:

1. verifying the solutions to tasks that students are required to complete during independent work with workshops presenting selected techniques in the field of databases; providing correct solutions results in the student being awarded a certain number of points for the workshop,
2. passing two topics, namely "User authentication and authorisation of operations in a database" and "The process of optimizing SQL statements", which is done by means of a final test (30 questions),
3. the design and defence of a database application by the student (final project).

From items 1 and 2, the student can obtain a maximum of 100 points in total, and for the completion of the project (item 3), the student can obtain a maximum of 100 points. The final total number of points that the student will obtain from the laboratory is calculated by adding the points from items 1 and 2 with a weight of 0.4 and the points from item 3 with a weight of 0.6. This sum is then converted into a final laboratory grade according to the following conversion table: <0;50%): unsatisfactory, <50%;60%): satisfactory, <60%;70%): satisfactory plus, <70%;80%): good, <80%;90%): good plus, <90%;100%>: very good.

### Programme content

The course programme covers the following topics.

1. Transactional processing as a response to system requirements for data processing correctness and efficiency in databases. Restoring a consistent database state after a failure using database logs. Definition of correctness of concurrent transaction execution and algorithms for managing concurrent transaction execution.

2. Disk data structures that guarantee efficient storage and processing of data in databases. Access methods that effectively implement relational data model operations. Processing and optimisation of queries in databases.
3. Distributed NoSQL databases as a tool for designing scalable and fault-tolerant database systems.

In the lab, students will learn about:

- 1) selected relational database access technologies,
- 2) methods of user authentication,
- 3) principles of granting permissions and methods of authorizing database operations,
- 4) the process of optimizing SQL statements including:
  - introduction to SQL optimization,
  - displaying execution plans for SQL statements.
  - indexes,
  - data access methods,
  - statistics,
  - join execution methods,
- 6) NoSQL database systems using MongoDB and Neo4J as examples.
- 7) elements of PL/SQL language.

## Course topics

The course syllabus covers the following topics:

- transactional processing in databases; transaction model; sources of errors and inconsistencies in the database state; ACID properties of transactions;
- database fault tolerance; atomicity and durability properties of transactions; database inconsistency anomalies; database logs; database buffer and log buffer management; the process of restoring a consistent database state after a failure; checkpoints.
- concurrent transaction processing anomalies; transaction isolation property; transaction conflict relation; transaction serializability property; serializability graphs; reproducibility, cascade rollback avoidance, and transaction strictness properties;
- transaction synchronisation algorithms, two-phase locking algorithms, timestamp algorithms, multi-version algorithms and optimistic transaction concurrency management algorithms;
- disk data structures in databases; database file organisation; sorted files and file fishing method; files organised by hash functions; dynamic hashing; single and multi-level indexes; structure and algorithms for maintaining B<sup>+</sup>-tree indexes; bitmap indexes;
- database access methods; external sorting and hashing; algorithms implementing relational join operations;
- query optimisation; logical and physical query plans; query tree transformation rules; cost function; estimating the intermediate sizes of processed data sets; estimating query selectivity; using histograms for compact representation of data distributions;
- NoSQL database management; greater scalability, fault tolerance and performance in distributed databases; data fragmentation, partitioning and sharding; data replication in distributed databases; consistency of distributed databases; CAP theorem.

The detailed topics, discussed in the course lab, are:

1. PL/SQL - a database programming language.
2. Software interfaces to databases.
3. Managing authorization of user actions in the database.
4. Optimising the execution of SQL statements.
5. NoSQL databases: exercises in the MongoDB system.

In parallel, students carry out a project to design a relational database schema and an application to support activities in a selected area of reality.

## Teaching methods

1. Lecture: multimedia presentation, presentation illustrated with examples, students solving sample tasks illustrating the issues presented in a given lecture.
2. laboratory exercises: multimedia presentation, presentation illustrated by examples given on the blackboard, practical exercises, workshops.

## Bibliography

### Basic:

1. Garcia-Molina H., Ullman J.D., Widom J., Implementacja systemów baz danych, WNT, 2003
2. J.D. Ullman, J. Widom, Podstawowy wykład z systemów baz danych, WNT, W-wa, 2000
3. Elmasri R., Navathe S., Wprowadzenie do systemów baz danych, Wyd. Helion, (4th Edition), 2005
4. Sadalge, P. J., Fowler, M., NoSQL Distilled: A Brief Guide to the Emerging World of Polyglote Persistence, 2013
5. Jakubowski: Podstawy SQL. Ćwiczenia praktyczne. HELION.
6. M. Gruber: SQL. HELION
7. R. Coburn: SQL dla każdego. HELION
8. M. Szeliga: ABC języka SQL. HELION

### Additional:

1. Database Management Systems, 2nd edition, R. Ramakrishnan, J. Gehrke, WCB/McGraw-Hill, 2001

## Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	56	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	69	3,00