I046	Elective Year III	**Modern Database Systems**	L	S	E	ECTS
			3	1	3	9

Course objectives. The main objective of the course is to acquire advanced skills in working on modern database systems. In the first part of the course, students are familiarized with abstract data models with emphasis on conceptual and logical modelling. Relational databases and Structured Query Language (SQL) are taught by using Oracle and/or MySQL relational database management systems. During the semester students are expected to develop skills in modelling and implementation of advance concepts in relational database design. Non-relational databases are also introduced on examples of MongoDB document database and Hadoop distributed database management system.

Course prerequisites. Introduction to Computer Science.

Syllabus.

1. **Introduction.** Data model. Database Management Systems. Examples.
2. **Abstract Data Models.** Conceptual modelling of databases. Entity-relationship model. Elements of entity-relationship model. Constraints in the entity-relation model. Weak Entity Sets.
3. Logical modelling of databases. Relational model of Data. Relational algebra. An algebraic query language. Constraints on relations. Functional dependencies. Design of Relational Database Schemas. Criteria for decompositions of relations. Boyce-Codd Normal Form. Third Normal Form. Multivalued Dependencies. Fourth Normal Form.
4. **Relational databases.** Introduction to Oracle and MySQL relational database management systems. Structured Query Language (SQL). Data Definition Language. Creating, altering, and dropping of tables. Simple queries in SQL. Queries involving more than one relation. Data Manipulation Language. Insertion, modification, and deletion of data. Primary and foreign keys. Constraints on attributes and tuples. Modification of Constraints.
5. Views and Indexes. Virtual views. Modifying views. Indexes in SQL. Selection of Indexes. Materialized views. SQL procedural language. Stored procedures, functions, and triggers.
6. Advanced topics in Relational Databases. Object-relational data model. On-Line Analytic Processing. Query Execution. Join algorithms. Query optimization. Concurrency Control. Transactions and lock mechanisms. Parallelism in database management systems.
7. **Non-Relational Databases**. Introduction to MongoDB document database management system. Creating, Updating, and Deleting Documents. Queries. Indexing. Aggregation. Design of Document Database. Sharing. Application and Server administration.
8. Distributed Database Systems. Introduction to Hadoop distributed database management system for big data. Introduction to MapReduce. The Hadoop Distributed Filesystem. MapReduce Algorithm. Developing a MapReduce Application.
9. Special purpose databases. Graph databases.

EXPECTED LEARNING OUTCOMES

No.	LEARNING OUTCOMES

1.	To demonstrate the knowledge and understanding which can serve as the foundation for developing and application of original ideas.
2.	To apply the knowledge, understanding and skills in a broad variety of problems concerning modern database systems.
3.	To integrate new knowledge concering modern database systems.
4.	To be able to present conclusions and findings to experts and laymen based on the knowledge and experience.
5.	To apply the acquired skills onto further education in this field.

COUPLING OF THE EXPECTED LEARNING OUTCOMES, TEACHING PROCESS ORGANIZATION AND THE EVALUATION OF THE TEACHING OUTCOMES

TEACHING PROCESS ORGANIZATION	ECTS	EXPECTED LEARNING OUTCOMES **	STUDENT ACTIVITY *	EVALUATION METHOD	SCORE	
					min	max
Lecture attendance	2	1-5	Class atendance, discussion, solving the problems individually and in a team	Lists with signatures, observing the activity during the lectures	0	10
Homework	3	1-4	Solving the problems individually	Grading	22	40
Repeated exams	2	1-4	Preparation for the written exam	Grading	16	30
Final exam	2	1-4	Revising	Oral exam	12	20
TOTAL	9				50	100

Teaching methods and student assessment. During lectures, advance concepts in relational and non-relational database design will be demonstrated by considering modern database systems. Practice sessions involve solving practical problems using following database management systems: Oracle, MySQL, MongoDB, and Hadoop. During the semester students solve homework problems that deal with the design and implementation of different databases. The seminar session is used for the presentation of homework solutions. Students can take written examinations. An

acceptable examination and homework scores replace the final written and oral examinations. Students can also do a project to improve the final grade.

Can the course be taught in English: Yes

Basic literature:

1. Hector Garcia-Molina, Jeffrey D. Ullman, and JenniferWidom. Database Systems: The Complete Book, volume 1. Prentice Hall, Jan 2009.

Recommended literature:

1. J. Price, Oracle Database 11g SQL, McGraw Hill Professional, 2007.
2. M. McLaughlin, Oracle Database 11g PL/SQL Programming, 2008.
3. K. Chodorow, MongoDB: The Definitive Guide, O'Reilly Media, 2013.
4. T. White, Hadoop: The Definitive Guide, Yahoo Press, 2012.
5. R. Manger: Baze podataka, 1. izdanje, Element, Zagreb, 2012.
6. R. Elmasri, S. Navathe: Fundamentals of Database Systems, 6th edition, Addison-Wesley, Reading MA, 2010.
7. A. Silberschatz, H. F. Korth, S. Sudarshan: Database System Concepts, 6th edition, McGraw- Hill, New York, 2010.
8. R. Ramakrishnan, J. Gehrke: Database Management Systems, 3rd edition, McGraw- Hill, New York, 2002.
9. C. Churcher: Beginning Database Design - From Novice to Professional. Apress, Berkley CA, 2007.
10. M.J. Hernandez: Database Design for Mere Mortals, 2nd Edition. Addison-Wesley, Reading MA, 2003.
11. R. Stephens: Beginning Database Design Solutions. Wrox, Hoboken NJ, 2008.
12. A. Beaulieu: Learning SQL. O'Reilly Media Inc, Sebastopol CA, 2009.
13. I. Robinson, Jim Webber, James Webber, E. Eifrem, Graph Databases, O'Reilly Media, 2013.
14. E. Redmond, J. R. Wilson, Seven Databases in Seven Weeks – A Guide to Modern Databases and the NoSQL Movement, Pragmatic Bookshelf, 2012.