SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Computer Science
1.4 Field of study	Computer Science and Information Technology
1.5 Cycle of study	Master
1.6 Program of study / Qualification	Data Science / Master
1.7 Form of education	Full time
1.8 Subject code	3.00

2. Data about the subject

2.1 Subject name	***DataBase Systems***				
2.2 Course responsible / lecturer	Lect. dr. eng. Antal Marcel - marcel.antal@cs.utcluj.ro				
2.3 Teachers in charge of seminars / laboratory / project	Lect. dr. eng. Antal Marcel - marcel.antal@cs.utcluj.ro				
2.4 Year of study	I	2.5 Semester	1	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	
2.7 Subject category	Formative category: DA – advanced, DS – speciality, DC – complementary				DS
	Optionality: DI – imposed, DO – optional (alternative), DF – optional (free choice)				DI

3. Estimated total time

3.1 Number of hours per week	3	of which:	Course	2	Seminars	-	Laboratory	1	Project	-
3.2 Number of hours per semester	42	of which:	Course	28	Seminars	-	Laboratory	14	Project	-
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										20
(b) Supplementary study in the library, online and in the field										20
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										10
(d) Tutoring										5
(e) Exams and tests										3
(f) Other activities:										
3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))										58
3.5 Total hours per semester (3.2+3.4)										100
3.6 Number of credit points										4

4. Pre-requisites (where appropriate)

4.1 Curriculum	
4.2 Competence	Relational Databases, Java Programming Language

5. Requirements (where appropriate)

5.1. For the course	Attending min 50% of the lectures to be admitted to take the final exam
5.2. For the applications	Compulsory attendance of 100% to be admitted to take the final exam

6. Specific competence

6.1 Professional competences	• analyse decentralised applications • create data models • define software architecture • define technical requirements

	• design cloud architecture • develop with cloud services • manage cloud data and storage • use data processing techniques • use software design patterns • use software libraries • utilise computer-aided software engineering tools
6.2 Cross competences	The graduate: • develop an analytical approach • taking a proactive approach • developing strategies to solve problems • being open minded • coordinate engineering teams

7. Expected Learning Outcomes

Knowledge	The student has knowledge of: • cloud technologies • computer science • data analytics • data models • data storage • data warehouse • database management systems (DBMS) • digital data processing • unstructured data
Skills	The student is able to: • create data sets • design databases in the cloud • develop data processing applications • establish data processes • implement data warehousing techniques • manage ICT data architecture • manage data • manage quantitative data • use data processing techniques • use databases • analyse pipeline database information • create data models[
Responsibilities and autonomy	The student has the ability to work independently in order to: • develop an analytical approach • take a proactive approach • develop strategies to solve problems • be open minded • coordinate engineering teams

8. Discipline objective (as results from the *key competences gained*)

8.1 General objective	The main objective of this program is to provide specific information and prepare students for working with modern database systems: both advanced relational database systems and also non-relational database systems

8.2 Specific objectives	The course aims to dive students in database technology concepts, so that they can understand database technology evolution and correlation with technological breakthroughs, as well as how NoSQL DBs were a natural evolution of traditional SQL systems. To achieve the objectives, the students will learn the modern database theory and explore the emergence and benefits of NoSQL databases. Students will learn principles behind such non- relational databases systems together with basic architectures and main data models of a NoSQL database: key-value stores, document databases, column-family stores, graph databases. Students will be able to explore the research aspects of advanced databases and will be able to research, analyse and use emerging technologies such as Big Data, NoSQL, Distributed Database Systems. As an outcome of the course, students will acquire the ability to choose the corresponding NoSQL database system according to their application needs, while considering non-functional requirements and future trends for data storage systems.

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Introduction: Database evolution from file storage systems to SQL and NoSQL systems.	2	Onsite	
DB Evolution and Big Data - How Big Data influenced DB evolution in the last decade	2		
Distributed SQL DBMS - DDBMS systems; Distributed transactions; Consistency – CAP theorem;	2		
Big data and Hadoop - Google Big data revolution; Map Reduce; Hadoop	2		
Building a Key-Value Store - Consistent Hashing; Building a distributed key-value store;	2		
Caching systems - Caching Systems; Case study: Redis	2		
Replication - DB Replication techniques	2		
Azure Blob Storage	2		
Azure Cosmos DB	2		
Document based NoSQL: Document based Databases; Case study: MongoDB	2		
Column based key-value: DB Indexing; Case study: Apache Cassandra	2		
Key-value store NoSQL: DB Partitioning; Case study: Amazon Dynamo DB	2		
Graph NoSQL: Graph Databases – Evolution and Classification; Case study: Neo4J;	2		
Future trends; Data Privacy and Ethical AI	2		

Bibliography

[1] Guy Harrison, Next Generation Databases, 2015 https://link.springer.com/book/10.1007/978-1-4842-1329-2

[2] Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, 2012

[3] Ramakrishnan, Raghu, and Johannes Gehrke. Database Management Systems 2nd ed. McGraw-Hill College, 2000. ISBN: 9780072322064

[4] Ghislain Fourny, The Big Data Textbook -Teaching large-scale databases in universities, 2024

[5] Alex Xu, System Design Interview - An Insider's Guide (Volume 1)

[6] Alex Xu, System Design Interview - An Insider's Guide (Volume 2)

[7] Thomas Erl, Big Data Fundamentals, Prentice Hall

[8] Martin Kleppmann – Designing Data Intensive Applications

9.2 Applications - Seminars / Laboratory / Project	Hours	Teaching methods	Notes
Laboratory Setup – Azure Portal Introduction	2	Onsite/ ZOOM	
Distributed caching -Redis Caching System	2		
Document Storage – Azure Cosmos DB or Mongo DB	2		
Key-Value Storage - Azure Cosmos DB or Amazon Dynamo DB	2		
Column Storage – Apache Cassandra	2		
Graph Storage – Neo 4J or Azure Cosmos DB for Graph Storage (Gremlin)	2		
Distributed application design, analysis and trade-offs evaluation	2		

Bibliography:

[1] Alex Xu, System Design Interview - An Insider's Guide (Volume 1)

[2] Alex Xu, System Design Interview - An Insider's Guide (Volume 2)

**Se vor preciza, după caz: tematica seminariilor, lucrările de laborator, tematica și etapele proiectului.*

10. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

This discipline aims to develop and complement the concepts and skills acquired during undergraduate studies, proposing to study advanced concepts of data decentralization, distributed databases and how to use NoSQL database technology to implement decentralized and scalable applications in different fields. These types of applications are becoming increasingly present in every commercial field.

11. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	The ability to solve domain specific problems Attendance, (inter)activity during class hours	Written Exam, activity during class hours	50%
Seminar	Tasks completion Attendance	Activity grading	50%
Laboratory	-	-	-
Project	-	-	-
Minimum standard of performance: Lab grade >=5, Course evaluation grade >=5			

Date of filling in: 01.09.2025	**Responsible**	**Title First name Last name**	**Signature**
	Course	Lect.dr.eng. Marcel ANTAL	
	Applications	Lect.dr.eng. Marcel ANTAL	

Date of approval in the department 17.09.2025	Head of department, Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council 19.09.2025	Dean, Prof.dr.eng. Vlad Muresan