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	Automation
1.4 Field of study	System's Engineering
1.5 Cycle of study	Master
1.6 Program of study / Qualification	Cyber Physical Systems
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name			***Big Data for Cyber-Physical Systems***	Subject code	7.00
2.2 Course responsible / lecturer			Assoc. Prof. Dr. Eng. Sanislav Teodora – teodora.sanislav@aut.utcluj.ro		
2.3 Teachers in charge of seminars / laboratory / project			Assoc. Prof. Dr. Eng. Sanislav Teodora – teodora.sanislav@aut.utcluj.ro		
2.4 Year of study	1	2.5 Semester	2	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
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	3.2 Course	2	3.3 Seminar	0	3.3 Laboratory	1	3.3 Project	0
3.4 Total hours in the curriculum	42	of which	3.5 Course	28	3.6 Seminar	0	3.6 Laboratory	14	3.6 Project	0

3.7 Individual study:	
(a) Manual, lecture material and notes, bibliography	20
(b) Supplementary study in the library, online and in the field	10
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	20
(d) Tutoring	5
(e) Exams and tests	3
(f) Other activities	0
3.8 Total hours of individual study (summ (3.7(a)…3.7(f)))	58
3.9 Total hours per semester (3.4+3.8)	100
3.10 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 Curriculum	• Concepts of designing, implementation and exploitation of relational and non-relational databases • Programming concepts (SQL, Java, Python)
4.2 Competence	• Concepts of using computers

5. Requirements (where appropriate)

5.1. For the course	Classroom with appropriate equipment to support an ongoing lecture (multimedia equipment)
5.2. For the applications	Laboratory room equipped with computers, network, Internet connection, specialized software

6. Specific competence

6.1 Professional competences	• Interacts professionally in research and professional environments • Adjusts product designs • Analyzes test data • Applies the principles of scientific ethics and integrity in research activities • Approves engineering projects • Ensures project management • Communicates scientific findings • Conducts interdisciplinary research • Conducts literature research • Develops professional networks with researchers • Develops open source software • Disseminates results to the scientific community • Demonstrates disciplinary expertise • Conduct scientific research • Perform quality control • evaluate research activities • Manage knowledge for strategic impact • Manage interoperable and reusable data that is accessible and easy to find • Manage research data • Manage personal professional development • Manages intellectual property rights • Manages open publications • Thinks abstractly • Integrates gender into research • Interprets technical drawings • Models and simulates hardware • Operates scientific and laboratory research equipment • Prepares prototypes for production • Presents analysis results • Designs hardware • Designs prototypes • Promotes public involvement in research • Promotes open innovation in research • Promotes knowledge transfer • Publishes academic research papers • Performs data analysis • Writes scientific and academic papers and technical documentation • Complies with regulations on prohibited materials • Develop scientific publications • Synthesizes information • Applies for research funding • Tests hardware • Uses technical drawing software • Speaks several foreign languages • Guides people • Records test data • Analyzes software specifications • Develops software prototypes • Uses software libraries
6.2 Transversal competences	• Show initiative • Think analytically • Apply scientific, technological, and engineering knowledge • Work in teams

7. Expected learning outcomes

Knowledge	The student will know: • Fundamental concepts, characteristics, storage models of Big Data • How to use well-known Big Data tools and platforms • Techniques for Big Data analysis • How to develop advanced applications with machine learning algorithms in Cyber Physical Systems and Big Data contexts
Skills	The student will be able to: • Design, develop, and implement software modules to manage the large amount of data provided by Cyber Physical Systems • Analyze technical data, evaluate alternatives, and apply problem-solving strategies to complex engineering challenges • Use machine learning algorithms with Big Data • Integrate multidisciplinary knowledge to design, optimize, implement, and evaluate innovative solutions for complex control systems and industrial networks • Conduct scientific and interdisciplinary research, analyze data, and communicate results effectively to professional and academic audiences
Responsibilities and autonomy	• The student will be responsible for carrying out professional or research projects in compliance with quality, safety, and security standard • The student will be responsible for ensuring ethical conduct, academic integrity, and proper management of research and experimental data • The student will be responsible for promoting collaboration, teamwork, knowledge transfer, and innovation within professional and research environments

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

8.1 General objective	Conveying the fundamental knowledge about the concept of Big Data and the understanding of how it can be leveraged in Cyber Physical Systems
8.2 Specific objectives	• Understanding of the characteristics and aspects associated with Big Data • Familiarity with tools and platforms supporting Big Data • Understanding of Big Data storage models • Assimilation of techniques for Big Data analysis

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Introduction to Big Data. Definitions, characteristics. Traditional approach vs Big Data. Applicability in the context of Cyber-Physical Systems (CPSs).	4	Lectures, demos, discussions	N/A
Big Data Platforms. Apache Hadoop ecosystem.	4		
Apache Hadoop tools for Big Data processing and analysis. MapReduce. Apache Pig.	2		
Apache Hadoop tools for Big Data processing and analysis. Apache HIVE. Apache Sqoop.	2		
Apache Hadoop tools for Big Data processing and analysis. Apache HBase.	2		
Big Data platforms. Apache Spark Ecosystem. Resilient Distributed Datasets (RDDs).	4		
Apache Spark libraries. SparkSQL and DataFrames.	2		
Apache Spark libraries. Machine Learning library (MLLib and Spark ML).	2		
Apache Spark libraries. Spark Streaming. GraphX.	2		
Other Big Data Platforms.	2		
Review	2		

Bibliography

1. Big Data Management and Analysis for Cyber Physical Systems, Loon Ching Tang, Hongzhi Wang, Ed. Springer, ISBN: 9783031175473, 2022.
2. NoSQL Databases A Complete Guide - 2020 Edition, Gerardus Blokdyk, Ed. 5STARCooks, ISBN: 978-065-590-933-0, 2019.
3. ***, Apache Hadoop, https://hadoop.apache.org/docs/current/, 2025.
4. ***, Apache Hive, https://hive.apache.org/, 2025.
5. ***, Apache Pig, https://pig.apache.org/, 2025.
6. ***, Apache HBase, https://hbase.apache.org/, 2025.
7. ***, Apache Spark, https://spark.apache.org/docs/latest/, 2025.
8. Learning Spark, 2nd Edition, Jules S. Damji, Brooke Wenig, Tathagata Das, Denny Lee, Ed. O'Reilly Media, Inc., ISBN: 9781492050049, 2020.
9. Exploring, Visualizing, and Modeling Big Data with R, Okan Bulut, Christopher Desjardins, 2021, https://okanbulut.github.io/bigdata/.
10. Lectures notes available at https://users.utcluj.ro/~tsanislav/teaching.html#bdcps.

9.2 Applications - Seminars/Laboratory/Project	Hours	Teaching methods	Notes
Installation and configuration of Big Data platforms and understanding of the concept	2	Presentation of examples, exercises, description of software programming environments, additional explanations, discussions	N/A
Big Data exemplification using Apache Hadoop - MapReduce, Apache Hive, Apache Pig, Apache HBase	4		
Big Data exemplification using Apache Spark – RDDs, DataFrames, Machine Learning, Streaming	4		
Development of software application for CPSs using Big Data techniques	4		

Bibliography

1. Laboratory materials available at https://users.utcluj.ro/~tsanislav/teaching.html#bdcps.

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

With the advancement of IT storage and processing technologies, Big Data has become a normality of our lives. Almost all industries are gearing up for the Big Data challenge by wanting to extract valuable insights from the data they store to address the challenges they face. The course content helps students manage large volumes of data (Big Data) in the context of Cyber Physical Systems and beyond. The subject content is consistent with what is taught in other universities abroad.

11. Evaluation

Activity type	11.1 Assessment criteria	11.2 Assessment methods	11.3 Weight in the final grade
11.4 Course	The ability to operate with the assimilated knowledge; The capacity of their application in practice.	Oral exam (project presentation)	100%
11.5 Seminars /Laboratory/Project	The ability to operate with the assimilated knowledge; The capacity of their application in practice.	Regular examinations	A/R

11.6 Minimum standard of performance

- Acquiring the basic elements regarding the Big Data concept in Cyber-Physical Systems
- Solving practical problems using Big Data tools and platforms
- Laboratory: ADMITTED, Exam grade >=5

Date of filling in: 10.07.2026	**Responsible**	**Title First name Last name**	**Signature**
	Course	Assoc. Prof. Dr. Eng. Sanislav Teodora	
	Applications	Assoc. Prof. Dr. Eng. Sanislav Teodora	

Date of approval in the department of Automation _____	Head of department, Prof.dr.eng. Honoriu VĂLEAN
Date of approval in the Faculty of Automation and Computer Science Council _____	Dean, Prof.dr.eng. Vlad MUREȘAN