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	Bachelor of Science
1.6 Program of study / Qualification	Computer science / Engineer
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Parallel and Distributed Computing***			Subject code	**55.2**
2.2 Course responsible / lecturer	Prof. dr. eng. Hângan Anca - Anca.Hangan@cs.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	As. drd. ing. Lazea Dragos - Dragos.Lazea@cs.utcluj.ro				
2.4 Year of study	IV	2.5 Semester	8	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: DF – fundamental, DS – speciality, DC – complementary				DS
	Optionality: DOB – mandatory, DOP – optional (alternative), DFA – optional (free choice)				DOP

3. Estimated total time

3.1 Number of hours per week	4	of which:	Course	2	Seminars	-	Laboratory	2	Project	-
3.2 Number of hours per semester	56	of which:	Course	28	Seminars	-	Laboratory	28	Project	-
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										23
(b) Supplementary study in the library, online and in the field										14
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										24
(d) Tutoring										4
(e) Exams and tests										4
(f) Other activities:										-

3.4 Total hours of individual study (suma (3.3(a)...3.3(f)))	69
3.5 Total hours per semester (3.2+3.4)	125
3.6 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1 Curriculum	Fundamental Algorithms, Fundamental programming techniques, Operating Systems, Structure of Computer Systems
4.2 Competence	C/C++ programming

5. Requirements (where appropriate)

5.1. For the course	Whiteboard, projector, computer
5.2. For the applications	Computers, Condor middleware, MPI library, C/C++ programming development environment

6. Specific competence

6.1 Professional competences	**C4** Improving the performances of the hardware, software and communication systems (2 credits) • **C4.1** Identifying and describing the defining elements of the performances of the hardware, software and communication systems • **C4.2** Explaining the interaction of the factors that determine the performances of hardware, software and communication systems • **C4.3** Applying fundamental methods and principles for increasing performance of hardware, software and communication systems • **C4.4** Choosing criteria and methods for performance evaluation of hardware, software and communication systems • **C4.5** Developing professional solutions for hardware, software and communication systems based on performance optimization
6.2 Cross competences	N/A

7. Expected Learning Outcomes

Knowledge	Describes, identifies, and summarizes advanced concepts, models, and methods related to complex computing systems and infrastructures, as well as distributed and parallel systems.
Skills	Applies and designs integrated computing solutions, including software and hardware systems and distributed/parallel systems, using analysis, design, implementation, and documentation methods.
Responsibilities and autonomy	Assumes responsibility for the quality, security, and correctness of the developed solutions and demonstrates autonomy in organizing design and learning activities, adapting to new requirements and technologies.

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

8.1 General objective	1. Students become aware of differences and similarities between parallel and distributed computing so the students understand the boundaries of both domains. 2. Students become familiar with the principles of designing parallel programs. 3. Students become familiar with the main classes of distributed algorithms.
8.2 Specific objectives	Parallel algorithms performance and scalability. Parallel algorithms design. Distributed algorithms: time synchronization, distributed mutual exclusion, causal ordering, leader election.

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Introduction to parallel and distributed computing.	2	Interactive lectures using PPT presentations and exercises carried on on-site.	
Parallel computers architecture	2		
Cache coherence in parallel computers	2		
Parallel programming models	2		
Parallel algorithm design: parallelization process, data dependency.	2		
Parallel algorithm design: case study.	2		
Parallel algorithm design: decomposition and assignment techniques.	2		

Improving the performance of parallel programs: load balancing issues.	2		
Improving the performance of parallel programs: serialization and communication issues.	2		
Workload-driven evaluation of parallel systems.	2		
Specialized hardware for parallel and distributed computing.	2		
Time: physical clocks, logical clocks. Causal ordering.	2		
Distributed algorithms: mutual exclusion.	2		
Distributed algorithms: leader election.	2		

Bibliography

1. *Programming on parallel machines* - GPU, multicore and clusters,N. Mathloff, Universityof California Davis, 2016 , http://heather.cs.ucdavis.edu/~matloff/158/PLN/ParProcBook.pdf
2. *Parallel and Distributed Computing - Lecture notes* – A. Hangan , Course materials on Microsoft Teams.
3. *Parallel Computer Architecture: A Hardware / Software Approach, D.E.Culler, J.P. Singh, A. Gupta, Morgan Kaufman Publishers, 1999*
4. *Introduction to Distributed Systems* -Concepts and design. George Coulouris, Jean Dollimore and Tim Kindberg, Prentice Hall, ISBN 0201-619-180, 2005, revised edition 2008
5. *Distributed computing : principles, algorithms and systems,* M. Singhal, A Kshemkalyani,Cambridge Univesrity 978-0521876346 , 2008

9.2 Applications – Seminars/Laboratory/Project	Hours	Teaching methods	Notes
Introduction to parallel computing.	2	Problem based approach.	
Parallel programming using message passing.	2		
Parallel algorithm design using message passing techniques. Implementation and evaluation: Count-min sketch.	4		
Parallel algorithm design using message passing techniques. Implementation and evaluation: Matrix multiplication implementation and evaluation.	4		
Parallel algorithm design using message passing techniques. Implementation and evaluation: simulation.	2		
Parallel algorithm design using shared memory techniques. Implementation and evaluation: simulation.	2		
Evaluation (parallel computing).	2		
Introduction to distributed computing.	2		
Problem solving in distributed environments. Algorithm implementation and evaluation. (Part I)	2		
Problem solving in distributed environments. Algorithm implementation and evaluation. (Part II)	2		
Evaluation (distributed computing)	2		

Bibliography

1. *Anca Hangan, Anca Rarau, Catalin Sipos, "Parallel and Distributed Computing", 2009, UTPRESS, ISBN: 978-973-662-484-1*
2. *Introduction to Parallel Computing*, V.Kumar, A. Grama, A. Gupta, G. Karypis, Benjamin-Cummings,ISBN 0-201-64

**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

As Cluj software workforce market gets more sophisticated, having solid knowledge of how to develop parallel programs and mastering the distributed computing are qualities that software companies look for.

11. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Formal assessment to test theoretical knowledge and problem solving skills. Attendance and activity.	Assignments written exam.	60%
Seminar	-	-	-
Laboratory	Formal assessment to test practical skills for designing parallel and distributed solutions and implementation . Attendance and activity.	Assignments and tests (using Moodle).	40%
Project	-	-	

Minimum standard of performance:
Design and implementation of parallel/distributed solutions using the theoretical models and tools (MPI, Condor grid middleware).
Pre-requisite for written exam: 6 mandatory lecture attendances.
Grade calculus: 40% laboratory + 60% course assignments and tests, final exam Conditions
for participating in the final exam: Laboratory grade ≥ 5
Conditions for promotion: Final grade ≥ 5

Date of filling in: 28.04.2026	**Responsible**	**Title First name Last name**	**Signature**
	Course	Prof. dr. eng. Anca HÂNGAN	
	Applications	As. drd. ing. Dragos LAZEA	

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