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	***Computer Architecture***			Subject code	**23**
2.2 Course responsible / lecturer	Assoc.prof.dr.eng. Negru Mihai - Mihai.Negru@cs.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	Assoc.prof.dr.eng. Negru Mihai - Mihai.Negru@cs.utcluj.ro				
2.4 Year of study	II	2.5 Semester	4	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: *DF – fundamental, DS – speciality, DC – complementary*				DF
	Optionality: *DOB – mandatory, DOP – optional (alternative), DFA – optional (free choice)*				DOB

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										28
(b) Supplementary study in the library, online and in the field										14
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										23
(d) Tutoring										-
(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	Logic design >= 5, Digital system design >= 5
4.2 Competence	Ability to design digital circuits and to implement them in VHDL

5. Requirements (where appropriate)

5.1. For the course	blackboard, video projector, laptop
5.2. For the applications	desktop/laptop computer, Xilinx Vivado, FPGA development boards

6. Specific competence

6.1 Professional competences	**C2 -** Designing hardware, software and communication components • **C2.1 -** Describing the structure and functioning of computational, communication and software components and systems • **C2.2 -** Explaining the role, interaction and functioning of hardware, software and communication components

	• **C2.3 -** Building the hardware and software components of some computing systems using algorithms, design methods, protocols, languages, data structures, and technologies • **C2.4 -** Evaluating the functional and non-functional characteristics of the computing systems using specific metrics • **C2.5 -** Implementing hardware, software and communication systems
6.2 Cross competences	• Technical communication and the ability to synthesize the information • Solving specific design issues for computing architectures • Structuring and organizing programs and data in the computing architectures memories • Teamwork

7. Expected Learning Outcomes

Knowledge	Describes, identifies, and summarizes elementary concepts and methods related to modeling, analysis, digital circuit design, and testing of computing architectures, namely: • Methods for representing and designing computing systems with digital circuits. • Specifications related to Instruction Set Architecture. • Implementation techniques for developing single-cycle, multi-cycle and pipeline RISC architectures. • Execution planning and branch prediction strategies. • Hierarchical memory organization through caching and virtualization.
Skills	Develops specific models for computing architecture components of and evaluates their functional and non-functional features. Designs and implements functional systems of low/medium complexity using programmable logic circuits (FPGA). Uses specific methods and tools for the implementation, analysis and simulation of computing architectures.
Responsibilities and autonomy	Shows spirit of initiative and action for updating the appropriate skills in professional, economical and organizational culture.

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

8.1 General objective	Knowing and understanding the concepts of organization and functioning for central processing units, memories, input/output, and using these concepts for design.
8.2 Specific objectives	• Applying methods for representation and design at system level for digital circuits • Instruction Set Architecture specification • Writing simple programs in assembly languages and machine code • Specification, design, implementation, and testing of central processing units, micro-architectures, data paths, command units • Understanding memory organization • Understanding modern trends in computer architectures

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Introduction	2	Oral presentation backed up by multimedia equipment, interactive communication, blackboard problem solving.	
High-Level Synthesis	2		
Instruction Set Architecture	2		
CPU Design – Single Cycle CPU	2		
Computer Arithmetic and Simple Arithmetic Logic Units	2		
CPU Design – Multi Cycle CPU Data path	2		
CPU Design – Multi Cycle CPU Control	2		

CPU Design – Pipelined CPU. Hazards	2		
Dynamic Scheduling of the Execution	2		
Speculative execution and Branch Prediction	2		
Memory	2		
Modern CPU Architectures	2		
Problem solving	2		
Problem solving	2		

Bibliography:

1. D. A. Patterson, J. L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", 5th edition, Morgan-Kaufmann, 2013, and newer editions.
2. J. L. Hennessy, D. A. Patterson, "Computer Organization and Design: A Quantitative Approach", 5th edition, Morgan-Kaufmann, 2011, and newer editions.
3. F. Oniga, "De la bit la procesor. Introducere în arhitectura calculatoarelor", U.T. Press, 2019, ISBN 978-606-737-366-0, available online: https://biblioteca.utcluj.ro/files/carti-online-cu-coperta/366-0.pdf
4. W. Stallings, "Computer Organization and Architecture", 11th edition, global edition, Pearson, 2021.
5. S. L. Harris, D. M. Harris, "Digital Design and Computer Architecture", RISC-V edition, Morgan-Kaufmann, 2021.
6. MIPS Technologies, Inc., "MIPS32 Architecture for Programmers, Volume I: Introduction to the MIPS 32™ Architecture".
7. MIPS Technologies, Inc., "MIPS32 Architecture for Programmers, Volume II: The MIPS 32™ Instruction Set".

9.2 Applications - Seminars / Laboratory / Project	Hours	Teaching methods	Notes
Introduction in the Vivado environment	2	Blackboard quick overview of key issues, exercises, experimenting with FPGA development boards with specialized IDEs for circuit design and implementation.	
Design and Implementation of arithmetic-logic unit	2		
Design and Implementation of memory components	2		
Design of a Single Cycle MIPS – Introduction	2		
Design of a Single Cycle MIPS – Instruction fetch	2		
Design of a Single Cycle MIPS – Instruction decode and control	2		
Design of a Single Cycle MIPS – Architecture completion	2		
Midterm practical evaluation on the FPGA board	2		
Pipelined MIPS CPU Design – Implementation	2		
Pipelined MIPS CPU Design – Hazard detection and correction	2		
Pipelined MIPS CPU Design	2		
Serial peripheral interfacing	2		
Practical evaluation of the pipelined MIPS CPU on the FPGA board	2		
Final Tests and Evaluation	2		

Bibliography (online):

1. M. Negru, F. Oniga, C. Vancea, Laboratory Guide https://mihai.utcluj.ro/computer-architecture, https://users.utcluj.ro/~onigaf/files/AC.html, https://users.utcluj.ro/~vcristian/AC.html
2. M. Negru, F. Oniga, S. Nedevschi, "Computer Architecture – Laboratory Guide", U.T. Press, 2015, ISBN 978-606-737-123-9, available online: https://biblioteca.utcluj.ro/files/carti-online-cu-coperta/123-9.pdf
3. C.-C. Vancea, F.I. Oniga, "Arhitectura Calculatoarelor – Îndrumător de laborator", U.T. Press, 2026, ISBN 978-606-737-834-4, available online: https://biblioteca.utcluj.ro/files/carti-online-cu-coperta/834-4.pdf

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

Computer Architecture is one of the fundamental subjects of the Computer Science and Information Technology field. It combines fundamental and practical aspects used for digital circuits design and implementation. The content of this subject is harmonized with the specific curricula of other national and international universities and is evaluated by the Romanian government agencies (CNEAA and ARACIS). The practical aspects involve getting familiar with and using development products and tools provided by companies from Romania, Europe, and USA (ex. Xilinx, Digilent).

11. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Testing the theoretical knowledge, the ability of problem solving, presence and activity	Written exam	50%
Laboratory	Practical ability to solve and implement specific problems related to processor design, presence and activity	Lab exam, periodical assessment of results	50%
Project	-	-	-

Minimum standard of performance:
Knowing the fundamental theory of the subject, the ability to design and implement a processor with a reduced set of instructions.
Conditions for participating in the final exam: Lab ≥ 5
Conditions for promotion: Final exam ≥ 5
Grade calculus: 50% lab + 50% final exam

Date of filling in: 29.04.2026	**Responsible**	**Title First name Last name**	**Signature**
	Course	Assoc.prof.dr.eng. Mihai NEGRU	
	Applications	Assoc.prof.dr.eng. Mihai NEGRU	

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