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
1.8 Subject code	23.

2. Data about the subject

2.1 Subject name	***Computer Architecture***				
2.2 Course responsible / lecturer	Assoc. prof. dr. eng. Mihai Negru - Mihai.Negru@cs.utcluj.ro - english Prof. dr. eng. Florin Oniga - Florin.Oniga@cs.utcluj.ro - romanian				
2.3 Teachers in charge of seminars / laboratory / project	Assoc. prof. dr. eng. Mihai Negru - Mihai.Negru@cs.utcluj.ro Prof. dr. eng. Florin Oniga - Florin.Oniga@cs.utcluj.ro Lect. dr. eng. Florin Dragos Lisman - dragos.lisman@cs.utcluj.ro Lect. dr. eng. Constantin Nandra - Constantin.Nandra@cs.utcluj.ro Lect. dr. eng. Cristian Vancea - Cristian.Vancea@cs.utcluj.ro Lect. dr. eng. Razvan Itu - Razvan.Itu@cs.utcluj.ro As. drd. eng. Mircea Muresan - Mircea.MURESAN@cs.utcluj.ro				
2.4 Year of study	II	2.5 Semester	2	2.6 Type of assessment (E - exam, C - colloquium, V - verification)	E
2.7 Subject category	*DF – fundamentală, DD – în domeniu, DS – de specialitate, DC – complementară*				DD
	DI – Impusă, DOp – opțională, DFac – facultativă				DI

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										0
(e) Exams and tests										4
(f) Other activities:										0

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 ISE / VIVADO, FPGA development boards

6. Specific competence

6.1 Professional competences	**C2 –** Designing hardware, software and communication components (5 credits) **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	N/A

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

7.1 General objective	Knowing and understanding the concepts of organization and functioning for central processing units, memories, input/output, and using these concepts for design.
7.2 Specific objectives	• Applying methods for representation and design at system level for digital circuits • Instruction Set Architecture (ISA) specification • Writing simple programs in assembly languages and machine code • Specification, design, implementation, and testing of Central Processing Units (CPU) – micro architecture – data path – command units • Understanding memory organization and I/O operations • Understanding modern trends in computer architectures

8. Contents

8.1 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 (ISA)	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	2		
Dynamic Scheduling of the Execution	2		
Speculative execution and Branch Prediction	2		
Superscalar Architectures	2		
Memory	2		
I/O and Interconnection Structures	2		
Problem solving	2		

Bibliography

1. D. A. Patterson, J. L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface",5th edition, ed. Morgan–Kaufmann, 2013, and newer editions.
2. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design: A Quantitative Approach",5th edition, ed. Morgan-Kaufmann, 2011.
3. F. Oniga, De la bit la procesor. Introducere în arhitectura calculatoarelor, Editura U.T. Press, Cluj-Napoca, 2019, ISBN 978-606-737-366-0, disponibil online, Romanian only.
4. Vincent P. Heuring, et al., "Computer Systems Design and Architecture", Addison-Wesley, USA, 1997.
5. A. Tanenbaum, "Structured Computer Organization", Prentice Hall, USA, 1999.
6. MIPS32 Architecture for Programmers, Volume I: "Introduction to the MIPS 32™ Architecture".
7. MIPS32 Architecture for Programmers, Volume II: "The MIPS 32™ Instruction Set".

Online bibliography

http://users.utcluj.ro/~negrum

8.2 Applications – Seminars/Laboratory/Project	Hours	Teaching methods	Notes
Introduction in the Xilinx ISE environment and the FPGA development board	2	Blackboard quick overview of key issues, exercises, experimenting with FPGA development boards with specialized IDEs for circuit design and implementation (Xilinx ISE)	
Design and Implementation of Combinational CPU Components	2		
Design and Implementation of Sequential CPU Components	2		
Design of a Single Cycle CPU 1 (MIPS)	2		
Design of a Single Cycle CPU 2 (MIPS)	2		
Design of a Single Cycle CPU 3 (MIPS)	2		
Design of a Single Cycle CPU 4 (MIPS)	2		
Midterm practical evaluation on the FPGA board	2		
Pipelined CPU Design	2		
Pipelined CPU Design	2		
Pipelined CPU Design	2		
Pipelined CPU interfacing	2		
Practical evaluation of the pipelined CPU on the FPGA board	2		
Final Tests and Evaluation	2		

Bibliography

Online bibliography

1. M. Negru, F. Oniga, S. Nedevschi, Laboratory guide http://users.utcluj.ro/~negrum
2. Florin Oniga, Mihai Negru, Arhitectura Calculatoarelor – Îndrumător de laborator, Editura U.T. Press, Cluj-Napoca, 2019, ISBN 978-606-737-350-9.
3. M. Negru, F. Oniga, S. Nedevschi, Computer Architecture - Laboratory Guide, U.T. Press, Cluj-Napoca, 2019, ISBN 978-606-737-123-9.

9. 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).

10. 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.
Grade calculus: 50% lab + 50% final exam
Conditions for participating in the final exam: Lab ≥ 5
Conditions for promotion: Final exam ≥ 5

	Teachers	**Title First name Last name**	**Signature**
Date of filling in: 16.06.2023	Course	Assoc. prof. dr. eng. Mihai Negru	
		Prof. dr. eng. Florin Oniga	
	Applications	Prof. dr. eng. Florin Oniga	
		Assoc. prof. dr. eng. Mihai Negru	
		Lect. dr. eng. Florin-Dragos Lisman	
		Lect. dr. eng. Cristian Vancea	
		Lect. dr. eng. Constantin Nandra	
		Lect. dr. eng. Razvan Itu	
		As. drd. eng. Mircea Muresan	

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. Liviu Miclea