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	***Structure of Computer Systems***			Subject code	**31**
2.2 Course responsible / lecturer	Prof. dr. eng. Sebestyen Gheorghe - Gheorghe.Sebestyen@cs.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	Prof. dr. eng. Hângan Anca - anca.hangan@cs.utcluj.ro Lect. dr. eng. Neagu Mădălin - madalin.neagu@cs.utcluj.ro				
2.4 Year of study	III	2.5 Semester	5	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	5	of which:	Course	2	Seminars	-	Laboratory	2	Project	1
3.2 Number of hours per semester	70	of which:	Course	28	Seminars	-	Laboratory	28	Project	14
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										20
(b) Supplementary study in the library, online and in the field										17
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										15
(d) Tutoring										-
(e) Exams and tests										3
(f) Other activities:										-

3.4 Total hours of individual study (suma (3.3(a)...3.3(f)))	55
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	Digital system design, Computer architecture
4.2 Competence	Understand and operate with basic concepts regarding computer system's hardware

5. Requirements (where appropriate)

5.1. For the course	
5.2. For the applications	

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. Expected Learning Outcomes

Knowledge	Describes, identifies, and summarizes fundamental concepts and methods related to the modeling, analysis, design, and testing of computing systems based on microcontrollers or processors. Describes, identifies, and summarizes advanced concepts, models, and methods related to complex computing systems and infrastructures.
Skills	Develops models for various hardware and software components of computing systems and evaluates their functional and non-functional characteristics. Designs and implements medium-complexity functional systems based on microprocessors. Applies and designs integrated computing solutions, including hardware and software systems, as well as distributed/parallel systems, using appropriate methods for analysis, design, implementation, and documentation.
Responsibilities and autonomy	Assumes responsibility for the quality, security, and correctness of the developed solutions and demonstrates autonomy in organizing design and learning activities, collaborating effectively within teams and adapting to new requirements and technologies.

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

8.1 General objective	The main goal of the course is to present in an accessible way advanced design methods and techniques used in today's microprocessors and computer systems
8.2 Specific objectives	To study: Methods and metrics for computer performance assessment Advanced CPU designs (pipelining, multicore, parallel and distributed computing) Memory hierarchies: cache memory, virtual memory, new DRAM technologies RISC architecture Parallel computers architectures – hardware issues and solutions

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Performance characteristics of computer systems	2	Lecture based on slides, onsite.	
Measuring the performance of computer systems	2		
Arithmetic and Logic Unit (integers)	2		
Arithmetic and Logic Unit (floating point)	2		

Central Processing Unit – advanced techniques	2		
Microprocessors – basic components and advanced implementations	2		
Multi-core systems	2		
Memory systems – memory technologies and design principles	2		
Memory hierarchies – cache memory and virtual memory	2		
Interconnection systems. Data transfer from I/O interfaces	2		
RISC architectures – principles and implementation examples	2		
Parallel computer architectures	2		
SIMD and SIMT architectures	2		
Technological perspectives in computer architecture	2		

Bibliography:

1. Gorgan Dorian, Sebestyen Gheorghe, Structura Calculatoarelor, Editura albastra, Cluj-Napoca 2005
2. Hennessy John, Patterson David, Computer architecture, a Quantitative Approach, Ed. Elsevier, 2007
3. Baruch, Z. F., Structure of Computer Systems, U.T.PRES, Cluj-Napoca, 2002, ISBN 973-8335-44-2.

9.2 Applications - Seminars / Laboratory / Project	Hours	Teaching methods	Notes
Measuring the performance of computer systems	2		
Measuring CPU execution time	2		
Designing ALU components (adders)	2		
Designing ALU components (multipliers)	2		
Communication protocols	2		
Stream data processing using AXI4-Stream	2		
Designing AXI4-Stream compliant modules	2		
Stream data processing. Use case: processing data from sensors	2		
Memory design (1)	2		
Memory design (2)	2		
DMA transfer using FPGA	2		
Practical implementation of a data processing system	2		
Review exercises	2		
Laboratory assessment	2		
Project development: design, implementation, and testing of a computing system	2		
Project presentations			

Bibliography:

1. Laboratory works available on Moodle
2. Intel, Using the RDTSC Instruction for Performance Monitoring [accessed Sept. 2024], https://www.ccsl.carleton.ca/~jamuir/rdtscpm1.pdf
3. Peter Kankowski, Performance measurements with RDTSC [accessed Sept. 2024], https://www.strchr.com/performance_measurements_with_rdtsc
4. John Lyon-Smith, Getting accurate per thread timing on Windows [accessed Sept. 2024], https: //web.archive.org/web/20090510073435/http://lyon-smith.org/blogs/code-o-rama/ archive/2007/07/17/timing-code-on-windows-with-the-rdtsc-instruction.aspx
5. AMBA 4 AXI4-Stream Protocol Specification - Arm [accessed Oct. 2024], https://documentation-service.arm.com/static/642583d7314e245d086bc8c9?token=
6. How the axi-style ready/valid handshake works [accessed Oct. 2024], https://vhdlwhiz.com/how-the-axi-style-ready-valid-handshake-works/
7. Vivado Design Suite User Guide: Designing with IP (UG896) - Using the IP Catalog [accessed Oct. 2024], https://docs.xilinx.com/r/en-US/ug896-vivado-ip/Using-the-IP-Catalog
8. Stimulus file read in testbench using TEXTIO [accessed Oct. 2024], https://vhdlwhiz.com/stimulus-file/
9. Crockett, L. H., Elliot, R. A., Enderwitz, M. A., & Stewart, R. W. (n.d.). *The Zynq book: Embedded processing with the ARM® Cortex®-A9 on the Xilinx® Zynq®-7000 all programmable SoC* (1st ed.). Department of Electronic and Electrical Engineering, University of Strathclyde

10. Z.F. Baruch, *Aplicatii de Proiectare Digitala cu Circuite FPGA*, ISBN 978-606-020-261-5,2020
11. AMD, „7 Series FPGAs and Zynq-7000 SoC XADC Dual 12-Bit 1 MSPS Analog-to-Digital Converter User Guide (UG480)", Sept. 2022. *[Online]. Available*: https://docs.amd.com/r/en-US/ug480_7Series_XADC/XADC-Overview

**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

The content of the course has been aligned with similar courses from the USA and Europe, as well as with the content of well-established textbooks used in prestigious universities. Additionally, the course content has been discussed with representatives of companies from Romania and the USA. The course has been evaluated by the ARACIS agency.

11. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Theoretical knowledge level	Written exam, onsite	60%
Seminar	-	-	-
Laboratory	Hardware Design skills	Practical evaluation, onsite	20 %
Project			20 %
Minimum standard of performance: Minimum 5 for the Course and for the Application assessment Grade calculus: 60% written exam + 20% laboratory evaluation + 20% project evaluation Conditions for participating in the final exam: Laboratory ≥ 5, Project ≥ 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. Gheorghe SEBESTYEN	
	Applications	Prof.dr.eng. Anca HÂNGAN	
		Lect.dr.eng. Mădălin NEAGU	

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