

SYLLABUS

1. Data about the program of study

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|--------------------------------------|---|
| 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 | Prof.dr.eng. Oniga Florin - Florin.Oniga@cs.utcluj.ro Assoc.prof.dr.eng. Negru Mihai - Mihai.Negru@cs.utcluj.ro Lect.dr.eng. Vancea Cristian-Cosmin - Cristian.Vancea@cs.utcluj.ro | | | | |
| 2.3 Teachers in charge of seminars / laboratory / project | Prof.dr.eng. Oniga Florin - Florin.Oniga@cs.utcluj.ro Assoc.prof.dr.eng. Negru Mihai - Mihai.Negru@cs.utcluj.ro Lect.dr.eng. Vancea Cristian-Cosmin - Cristian.Vancea@cs.utcluj.ro Assoc.prof.dr.eng. Itu Răzvan - Razvan.Itu@cs.utcluj.ro Lect.dr.eng. Lişman Florin Dragoş - Dragos.Lisman@cs.utcluj.ro Lect.dr.eng. Nandra Constantin - Constantin.Nandra@cs.utcluj.ro Lect.dr.eng. Mureşan Mircea-Paul - Mircea.Muresan@cs.utcluj.ro As.eng. Attila Ernő Füzes - Attila.Fuzes@cs.utcluj.ro As.eng. Vivian Chiciudean - Vivian.Chiciudean@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 DI – Impusă, DOp – opțională, DFac – facultativă | | | | DD |
| | | | | | 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)

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|----------------|--|
| 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)

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|---------------------------|---|
| 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

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|------------------------------|---|
| 6.1 Professional competences | C2 – Designing hardware, software and communication components <ul style="list-style-type: none"> 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*)

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|-------------------------|---|
| 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 | <ul style="list-style-type: none"> 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 |

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 | 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”, 5 th edition, Morgan–Kaufmann, 2013, and newer editions. | | | |
| 2. J. L. Hennessy, D. A. Patterson, “Computer Organization and Design: A Quantitative Approach”, 5 th 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, disponibil online, Romanian only.
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".

| 8.2 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 bibliography

1. M. Negru, F. Oniga, C. Vancea, Laboratory Guide <https://mihai.utcluj.ro/computer-architecture>, <http://users.utcluj.ro/~onigaf>, <http://users.utcluj.ro/~vcristian/AC.html>
2. F. Oniga, M. Negru, "Arhitectura Calculatoarelor – Îndrumător de laborator", U.T. Press, 2019, ISBN 978-606-737-350-9.
3. M. Negru, F. Oniga, S. Nedevschi, "Computer Architecture – Laboratory Guide", U.T. Press, 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.

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: 26.02.2025 | Responsible | Title, First name Last name | Signature |
|-----------------------------------|--------------|-------------------------------------|-----------|
| | Course | Prof.dr.eng. Florin ONIGA | |
| | | Assoc.prof.dr.eng. Mihai NEGRU | |
| | | Lect.dr.eng. Cristian-Cosmin VANCEA | |
| | Applications | Prof.dr.eng. Florin ONIGA | |
| | | Assoc.prof.dr.eng. Mihai NEGRU | |
| | | Lect.dr.eng. Cristian-Cosmin VANCEA | |
| | | Assoc.prof.dr.eng. Răzvan ITU | |
| | | Lect.dr.eng. Florin-Dragoș LIȘMAN | |
| | | Lect.dr.eng. Constantin NANDRA | |
| | | Lect.dr.eng. Mircea-Paul MUREȘAN | |
| | | As.eng. Attila Ernő FÜZES | |
| | | As.eng. Vivian CHICIUDEAN | |

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