



COURSE DESCRIPTION

1. Program identification information

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|----------------------------------|---|
| 1.1 Higher education institution | National University of Science and Technology Politehnica Bucharest |
| 1.2 Faculty | Electronics, Telecommunications and Information Technology |
| 1.3 Department | Telecommunications |
| 1.4 Domain of studies | Electronic Engineering, Telecommunications and Information Technology |
| 1.5 Cycle of studies | Bachelor/Undergraduate |
| 1.6 Programme of studies | Applied Electronics |

2. Date despre disciplină

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|---|---|-----------------------------|---------------|----------------------|------|-------------------|----|
| 2.1 Course name (ro) | | Circuite integrate digitale | | | | | |
| (en) | | Digital Integrated Circuits | | | | | |
| 2.2 Course Lecturer | | Lect. Zoltan HASCSI, PhD | | | | | |
| 2.3 Instructor for practical activities | | Lect. Zoltan HASCSI, PhD | | | | | |
| 2.4 Year of studies | 2 | 2.5 Semester | II | 2.6. Evaluation type | E | 2.7 Course regime | Ob |
| 2.8 Course type | D | 2.9 Course code | 04.D.04.O.017 | 2.10 Tipul de notare | Nota | | |

3. Total estimated time (hours per semester for academic activities)

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|--|-------|--------------------------|------|-------------------------|-------|
| 3.1 Number of hours per week | 4.5 | Out of which: 3.2 course | 2.00 | 3.3 seminary/laboratory | 2.5 |
| 3.4 Total hours in the curricula | 63.00 | Out of which: 3.5 course | 28 | 3.6 seminary/laboratory | 35 |
| Distribution of time: | | | | | hours |
| Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc. | | | | | 60 |
| Tutoring | | | | | 1 |
| Examinations | | | | | 1 |
| Other activities (if any): | | | | | 0 |
| 3.7 Total hours of individual study | 62.00 | | | | |
| 3.8 Total hours per semester | 125 | | | | |
| 3.9 Number of ECTS credit points | 5 | | | | |

4. Prerequisites (if applicable) (where applicable)

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| 4.1 Curriculum | Computer Programming Algebra Electronic Devices |
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| 4.2 Results of learning | General principles of structured programming Functional description of electronic devices |
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5. Necessary conditions for the optimal development of teaching activities (where applicable)

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| 5.1 Course | Room equipped with a video projector |
| 5.2 Seminary/ Laboratory/Project | Room with computers/workstations Xilinx Vivado IDE FPGA development board Compulsory presence at laboratory classes, according to current NUSTPB regulations. |

6. General objective (Referring to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the curricula of the study programme, etc. will be described in a general manner)

The course answers the following questions:

- What is a digital system?
- How to describe a digital system?
- How to simulate a digital system?
- How to synthesize a digital system?
- How to design a moderately complex digital system?

Tackling the complexity and the functional diversity will enable students to design the simplest programmable system. Thus they are prepared to address the systems for which the functionality is achieved by physical and informational structuring.

Students will learn to use IDE tools to design and verify their digital circuits, and FPGA boards to implement and test them.

7. Competences (Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and professional growth. They reflect the employers requirements.)

| | |
|--|---|
| Specific Competences | Design , verification, implementation and testing of small- and medium-complexity digital circuits. Use of specific software and hardware tools. Analysis of schematics/descriptions of digital circuits. Understanding/infering their behavior. |
| Transversal (General) Competences | Honorable, responsible and ethical behavior to ensure the reputation of the profession. Awareness of the need for continuous training. Efficient use of resources and learning techniques for personal and professional development. Understanding English terms. Ability to use documentation sources (standards, specifications, catalog data) in English. |

8. Learning outcomes (Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's accomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The



learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)

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|---|---|
| <p>Knowledge</p> | <p><i>The result of knowledge acquisition through learning. The knowledge represents the totality of facts, principles, theories and practices for a given work or study field. They can be theoretical and/or factual.</i></p> <p>Define the basic concepts of binary arithmetic and Boolean algebra. Describe logical functions using algebraic/tabular/graphical representations. Describe methods for automata description with graphs/flowcharts/state diagrams. Exemplify and characterize digital circuit implementation technologies. Describe the basic structures of digital circuits and explain their operation. Define metrics for digital circuit characterization and describe measurement/estimation methods for them. Exemplify digital circuit analysis/design methodologies. Enumerate and describe their stages. Understand the terms, abbreviations, acronyms and symbols used in the field of digital circuits.</p> |
| <p>Skills</p> | <p><i>The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and instrumentation).</i></p> <p>Draw the diagram of a digital circuit, at the level of transistors/logic gates/function blocks. Behaviorally/structurally describe a logic circuit using verilog language. Interpret the waveforms of a digital circuit simulation. Identify functional blocks in a digital circuit and infer its behavior to different input stimuli. Analyze a digital circuit diagram and deduce the logic function in the form of logic expression/diagram/graph. Design a combinational logic circuit using logic expressions/truth tables/VK diagrams. Design an automaton using state diagrams/graphs/flowcharts. Design a digital circuit combining generic functional blocks (mux, dmux, encoder, decoder, adder, comparator, register, counter, etc.). Define scenarios for generating input stimuli for a digital circuit and predict its response. Find and correct errors in the design and/or description of a non-functional circuit.</p> |
| <p>Responsability and autonomy</p> | <p><i>The student's capacity to autonomously and responsibly apply their knowledge and skills.</i></p> <p>Efficiently use the software tools and hardware resources for learning, analysis and design. Select appropriate documentation sources. Reuse and adapt old modules/circuits for new problems. Demonstrate autonomy in planning and implementing solutions to given problems, as well as identifying and correcting errors/mistakes. Collaborate with other colleagues and teaching staff in carrying out teaching activities. Responsibly apply the principles, norms and values of professional ethics in completing homework and laboratory assignments. Self-evaluate objectively, identifying gaps and needs, provide proactive feedback.</p> |

9. Teaching techniques (Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)

Teaching is based on the use of the videoprojector (covering communication and demonstration function). The oral communication methods are expository method and problem-solving method. Course materials are lecture notes and presentations. The lecture slides and course activities are available online on the faculty's "Moodle" platform.



10. Contents

| COURSE | | |
|---------|---|-----------|
| Chapter | Content | No. hours |
| 1 | Introduction. Analog vs. digital. Combinational vs. sequential. Basic blocks: gates, flip-flops, registers. | 2 |
| 2 | Boolean algebra axioms. Elementary logic gates. CMOS implementation. | 2 |
| 3 | Boolean algebra theorems. Combinational logic circuits. | 4 |
| 4 | General-purpose CLCs: multiplexers and demultiplexers. | 2 |
| 5 | Complex CLCs. | 2 |
| 6 | Bistables. Flip-flops. Registers. | 2 |
| 7 | Counters | 2 |
| 8 | Memories. ROM. RAM. | 2 |
| 9 | Automata | 4 |
| 10 | Arithmetic circuits. Adders. Shifters. Multipliers. | 2 |
| 11 | Digital systems. Structured design. Size and complexity. | 4 |
| | Total: | 28 |

Bibliography:

- <http://curs.upb.ro/>
- Morris Mano. Michael Ciletti. Digital Design, 4th Ed. Pearson-Prentice Hall, 2007

| LABORATORY | | |
|------------|---|-----------|
| Crt. no. | Content | No. hours |
| 1 | Introduction to Vivado (project, simulation, synthesis) | 2 |
| 2 | Introduction to Verilog (module, instance etc) | 2 |
| 3 | CLC. Multiplexers. Adders. | 2 |
| 4 | Decoders. LCD Display. BCD Converter. | 2 |
| 5 | CLC project (decimal adder) | 2 |
| 6 | CLC colloquium | 2 |
| 7 | Flip-flops. Shift register | 2 |
| 8 | Counters | 2 |
| 9 | ROM and RAM memories | 2 |
| 10 | Mealy and Moore FSMs | 2 |
| 11 | CLS project (triangular sequence generator) | 2 |
| 12 | CLS colloquium | 2 |
| 13 | Complex project (pocket calculator) | 4 |
| | Total: | 28 |

SEMINARY

| Crt. no. | Content | No. hours |
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|---|--------------------------------------|---|
| 1 | Binary arithmetic | 1 |
| 2 | Normal disjunctive/conjunctive forms | 1 |
| 3 | Logic functions with MUX and DMUX | 1 |
| 4 | V-K diagrams | 1 |
| 5 | Minimizations with V-K diagrams | 1 |
| 6 | Automata with D flip-flops | 1 |
| 7 | Automata with counters | 1 |
| | Total: | 7 |

Bibliography:

- [https://wiki.dcae.pub.ro/index.php/Digital_Integrated_Circuits_\(lab\)](https://wiki.dcae.pub.ro/index.php/Digital_Integrated_Circuits_(lab))

11. Evaluation

| Activity type | 11.1 Evaluation criteria | 11.2 Evaluation methods | 11.3 Percentage of final grade |
|--|---|-------------------------|--------------------------------|
| 11.4 Course | knowledge of fundamental theoretical concepts | Quick tests | 10% |
| | knowledge of fundamental theoretical notions; design and verification of a digital circuit in verilog; the ability to use simulation and synthesis tools; | Final exam | 40% |
| 11.5 Seminary/laboratory/project | verilog description and simulation of combinational digital circuits | colloquium | 20% |
| | verilog description and simulation of sequential digital circuits | colloquium | 30% |
| 11.6 Passing conditions | | | |
| At least 50% of the total marks. At least 50% of the marks allotted to laboratory colloquiums | | | |

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

The course introduces the most important theoretical and practical elements that are necessary for digital design of low and medium complexity digital systems using Verilog HDL, offering specific abilities that will help students to obtain jobs in companies specialized in digital design.

Date

Course lecturer

Instructor(s) for practical activities

09.09.2022

Lect. Zoltan HASCSI, PhD

Lect. Zoltan HASCSI, PhD



Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației



Date of department approval

Head of department

16.10.2024

Conf. Dr. Bogdan Cristian FLOREA

Date of approval in the Faculty Council Dean

25.10.2024

Prof. Dr. Mihnea Udrea